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THE CAPTIVE BALLOON IN THE NAVY.

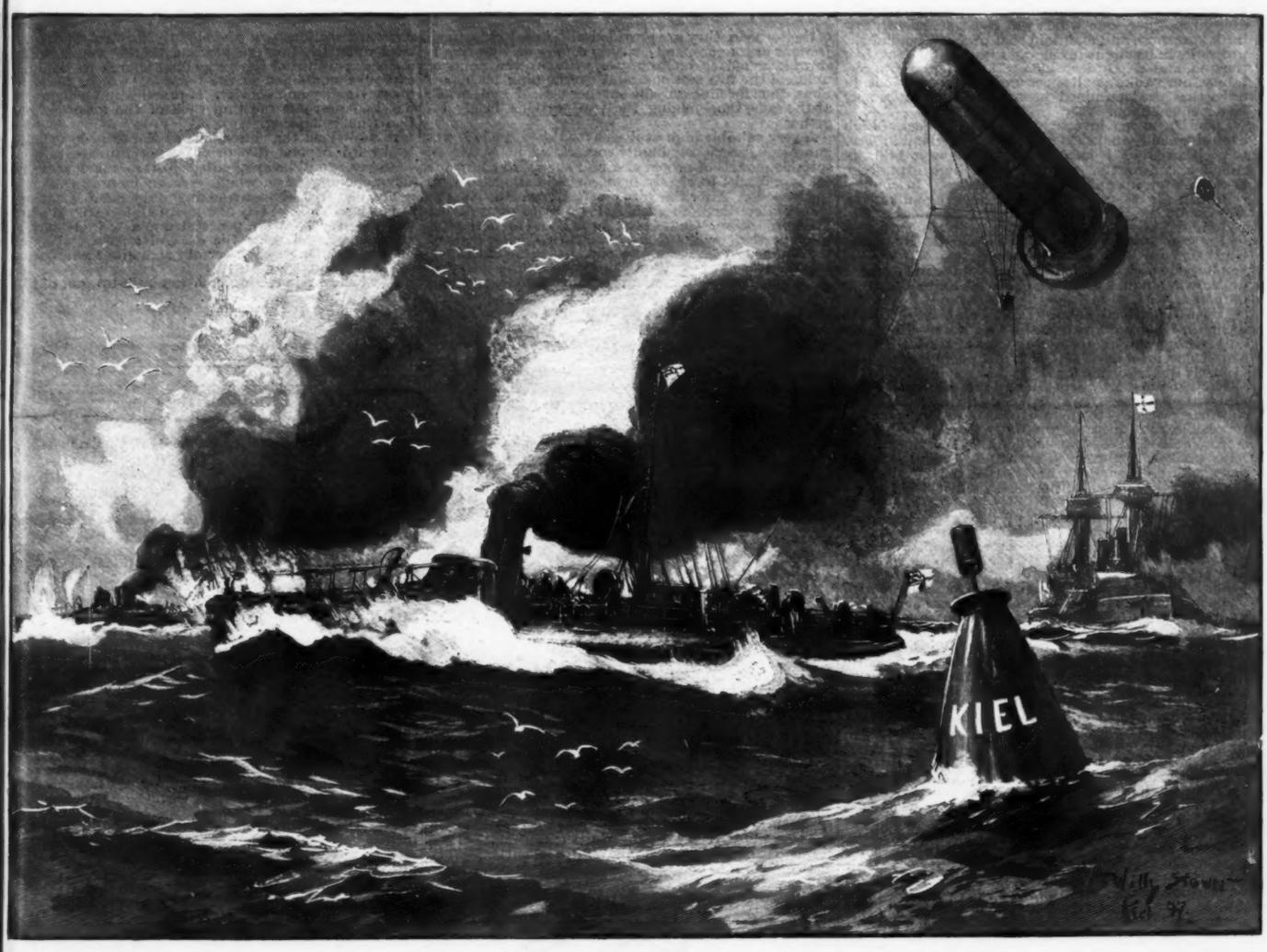
At the recent naval maneuvers at Kiel, Germany, the aeronautic division of the German army went through a two weeks' drill, in which the kite balloon described in our paper some little time ago was used for reconnoitering, being made captive on board a torpedo boat.

We may just shortly remind our readers of the construction of the balloon. By means of an attachment on one end, the body, which is elongated, is kept at an angle to the horizontal. The wind, therefore, catches the slanting lower surface as it strikes a kite. The balloon is provided with an air chamber on this surface which prevents it from giving way to the stress and curving. Lastly, there is the usual kite tail, which is raised aloft by an additional circular balloon. The car is independent of the cable which holds the balloon fast. By all these devices great steadiness is secured, and consequently very exact observations can be made.

To be able to transport the balloon quickly from one place to another, the aeronautic division attached it to a torpedo boat, which, owing to its great speed, answered the purpose admirably. But not only was the balloon conveyed from one place to another by this means. The machinery by which the cable was paid out was even transferred from one boat to another without much difficulty.

Experiments were conducted to compare the range of vision from the car with that obtained on lighthouses. The balloon was sent up off Bülk (near Kiel), where a lighthouse rises 97½ feet above the ground. From this tower one can see fifteen miles around, while from the balloon a strong telescope revealed the whole of the Danish seas, even beyond Copenhagen, while in the east Rügen could be distinguished, and in the west the North Sea was visible. The officers of the army and navy practiced recognizing the different ships which were clearly seen in the Great Belt. It is to be expected that this enlarging of the field of vision will be of great importance in naval warfare, as an early recognition of the enemy is always essential.

Our cut is taken from Illustrirte Zeitung.



TORPEDO BOAT TOWING A BALLOON.

POSSIBLE STEAMSHIP SERVICE BETWEEN NEW YORK AND TANGIER.

CONSUL BURKE sends the following from Tangier, June 21, 1897: In view of the opportunity for developing considerable trade between New York and Morocco if steamers touched at this port, I wrote during the past winter to two New York agencies of steamship lines to the Mediterranean to ascertain if it would not be possible and profitable for the companies to include Tangier in their itinerary. The agents of one of the lines informed me it would not be to their advantage, especially as the larger number of passengers by their line did not care to touch at Tangier. The agents of the other line wrote me they would refer my letter to Messrs. Gastaldi & Company, the general agents at Genoa. I also wrote other parties in the United States, asking them to be good enough to interest themselves in the matter, as I felt sure that if steamers touched regularly at this port both from and to New York it would result in our gaining a strong commercial foothold in this country. Whether my efforts in this direction accomplished anything I do not know. I am rejoiced, however, to be able to report that the steamer Sarnia, of the Atlantic line to the Mediterranean, of which Gastaldi & Company are general agents, is advertised to touch at this port on July 2, en route to New York. I understand this is an experiment only; but there is no doubt in my mind that if we have even a monthly service for a few months it will be found necessary, on account of the increase of trade, to establish a bimonthly service for this port. All interested in getting a share of this market for our manufactured products should give aid and encouragement to the proposed venture, in order to render it a success. I have written Messrs. Gastaldi & Company, of Genoa, assuring them that whatever can be done by me shall be done to aid the undertaking. Now, whatever is shipped to the United States goes by way of England, Germany and France. Whatever is brought from the United States must come through the same countries and must of necessity occupy a much longer time in transit. Probably the freight charges are higher when goods are brought in this roundabout way. If the company decides to have a monthly service for this port, our manufacturers and merchants should put commercial travelers in this field at once with samples of their products. A sample house should be opened, with a man at the head who is active, enterprising and shrewd. He should be a man who knows the country and the people, not only of Tangier, but all the coast towns. The whole of Morocco would be his field, and our people would reap benefit. I sincerely hope that the experiment by the Atlantic Line Company in touching at this port will prove successful for them and beneficial in opening a new channel of trade for us, though it may not be very extensive.

The construction of the line Crampass-Sassnitz on Rugen, Germany, which was completed on May 1, offered several difficulties. In some two miles the trains have to ascend a grade of 97 feet. To make the ascent even it was found necessary to cut into the Crampass plain from Crampass to the sea shore. But a greater difficulty yet had to be overcome in laying the track along the shore, where the whole line had to be protected by a sea wall, the building of which involved considerable expense.—Uhland's Wochenschrift.

A NEW SYSTEM OF THROWING HIGH EXPLOSIVES.*

By Hudson Maxim.

For a generation there has been a race for supremacy between guns and armor, between penetration and resistance, between offense and defense. This race has resulted in the development of cannon of comparatively small caliber, but with great thickness of wall and tremendous weight, in order to withstand the enormous pressures necessary to impart requisite velocities to long and heavy armor-piercing projectiles. Powder space within the armor-piercing shell has been sacrificed to weight and strength of metal, reliance being mainly placed upon the smashing effect of a huge bolt of steel. Opposed to this we find the modern battleship, clothed in a wall of steel so ponderous as to reduce mobility to a minimum.

Now, with the advent of a system of throwing high explosives, in sufficiently large masses to render armor absolutely useless, we shall find navies discarding their armor, and everything will be made subservient to speed and mobility. This will work a complete revolution in the construction of ordnance and ships of war. Heavy ordnance, instead of being made, as at present, of small caliber, with thick and heavy walls, will be made of much greater caliber, and with comparatively thin walls. The projectile which will then be employed will be a thin shell, simply thick enough to support the mass of contained explosive in its flight from the gun; and the explosive will be sufficient in quantity to work infinitely more destruction upon any target than such projectiles as are at the present day thrown from heavy guns.

One of the requisites of primary importance to a system of successfully throwing high explosives in large masses rests upon the propelling charge—upon a suitable gunpowder—one which will give a sufficiently low initial pressure, and maintain that pressure behind the projectile in its flight throughout the entire length of the gun, and a powder which will, with absolute certainty, burn alike at all times under like conditions, in order that predetermined pressure and velocities may be depended upon.

I first began the investigation of the subject of high explosives and smokeless powders in England in 1889. Since that time I have built two powder mills in America, one for the manufacture of high explosives, the other for smokeless cannon powders. In connection with my other work on these lines, I conducted a large number of experiments for the Pneumatic Torpedo and Construction Company, of New York, formerly known as the Zalinski Pneumatic Dynamite Gun Company, looking to the production of a smokeless torpedo powder; that is, a powder for the purpose of throwing high explosives, or aerial torpedoes, from ordnance.

The distinguished chemist Dr. Robert C. Schüpphaus has been associated with me in this work. He is also an inventor, and his extensive chemical knowledge and experience in connection with nitro compounds particularly qualified him for this work.

Owing to the shortness of range of the pneumatic guns, and to the expense, cumbersomeness and vulnerability of the plant necessary to operate them, it was determined, if possible, to substitute gunpowder for compressed air.

How well we have succeeded in the Maxim-Schüpphaus smokeless powder to accomplish the desired results, and the special advantages that this powder has for the purpose, is one of the things which I shall here try to explain.

One of the great advantages of high explosives as an agency of destruction is the impossibility of opposing to them any efficient means of protection, when applied in large quantities. By the subdivision of the hull of the modern battleship into a honeycomb of water-tight compartments, and by surrounding it with torpedo netting, some protection is secured against attack from even the largest of present forms of torpedoes, such as the Whitehead, but the largest and latest type of these will carry but 200 lb. of guncotton. It remains only to be able to attack with a sufficiently large quantity of explosive in order to render absolutely useless as a means of protection all precautions in the form of network and water-tight compartments. Five hundred pounds of guncotton exploded against the torpedo netting surrounding a modern battleship would insure her destruction, to say nothing of what would result from the explosion of still larger quantities.

The nearest approach to the system proposed by me for throwing high explosives that has yet been developed is the system of throwing them by means of compressed air. But the shortness of range of pneumatic guns, the difficulty and expense of protecting them, and the enormous plant of engines, boilers and air compressors necessary, are strong objections to their use for coast defense; while their cumbersomeness and vulnerability, together with the above objections, render their employment on shipboard entirely out of the question.

With the 15 inch pneumatic guns that have been erected in the United States, at Sandy Hook and San Francisco, 500 lb. of high explosive may be thrown a distance of about one mile and a quarter; 200 lb. about two and a half miles; this is the maximum range. Hence a battleship could lie just beyond the range of these guns and destroy the entire outfit, without in turn being in the least exposed to the fire of the pneumatic tubes. It is obvious, therefore, that a practical system of throwing aerial torpedoes must have a range substantially equal to that of high-power guns opposed to it, and the quantity of high explosive thrown must be sufficient to effect upon the target greater destruction than can be effected by ordinary shells thrown from heavy ordnance.

Fig. 1 is a sectional view of my improved aerial torpedo and fuse, carrying half a ton of compressed wet guncotton. Fig. 2 is a 12 inch torpedo of the same pattern, carrying 250 lb. of guncotton. The object of this invention is mainly to provide an aerial torpedo projectile which shall carry a maximum of high explosive with a minimum weight of metal, and at the same time be of such constitution, strength, and integrity as to enable it to withstand the shock of acceleration and the pressure of the propelling gunpowder charge, without danger of disruption or distortion of the torpedo, or the premature explosion of it.

* Digest of a paper read before the United Service Institution, London.

The torpedo projectile is preferably made in two sections, a forward and a rearward portion, and joined together in the following manner: The forward portion is made somewhat thicker than the rearward, and the rear end of the forward section is reduced in thickness sufficiently to permit of the two portions being telescoped together, as shown in the drawing. The parts are made to fit closely, and are forced together with considerable pressure, in order to make a very tight joint.

To effect the simultaneous rotation of both portions of the torpedo, they are provided with interlocking projections or tongues, and a strong copper driving ring is shrunk or affixed on the projectile at the point of union of the two sections, and overlapping both portions, thus forming an efficient hermetical seal, while at the same time joining the two portions firmly together.

A very suitable high explosive for this torpedo is wet guncotton, previously highly compressed in a series of suitable moulds of proper size and shape, to adapt the cakes or blocks to closely fit a corresponding space in the torpedo. After the torpedo has been filled in the manner described, to such fullness as to prevent the rearward section being forced quite home upon the forward portion, or abutting against the thicker body of the forward section, the two ends are placed together, and the torpedo is subjected to considerable pressure in a longitudinal direction, sufficient to secure the maximum density of the contained high explosive charge. The gas check and driving ring is then affixed in the manner already explained.

When compressed guncotton is used for filling the torpedo in the manner described, its density and unyielding nature cause it to serve as a support to the walls of the projectile and prevent its disruption or distortion under the great pressure of gases of the gunpowder charge, and the sudden shock of acceleration, thus permitting the use of thinner walls than when filled with a more yielding material.

The walls of the forward section of the torpedo are made thicker than those of the rearward portion, in order to give greater weight to the forward end of the torpedo to secure a truer flight, and also such strength as to enable it to penetrate deck armor or earthworks before exploding.

Figs. 3 and 4 illustrate the position of the guncotton torpedo in the gun, as well as its size, compared with other forms of projectiles now in use, thrown from guns of half the caliber, but of greater weight, and the same exterior dimensions from forward of the trunnions back to the rear of the gun.

The whole of the rearward section of the torpedo projects backward from the driving ring and ring seat into the powder chamber, so that the entire rear portion of the torpedo is surrounded by the gases of the propelling powder charge, which exert their pressure upon it simultaneously on all sides, causing the rearward section to move slightly forward and press hard upon the forward portion, thereby communicating the pressure of the propelling charge to the high explosive contained in the torpedo, which, from its great rigidity and density, is practically incompressible, and prevents the thin shell of the rearward section from collapsing.

It is obvious that insomuch as the torpedo extends backward beyond the driving ring into the powder chamber, it will be accelerated just so much more by the propelling gases, which give an increased velocity equivalent to a like lengthening of the gun.

The fuse employed is one adapted to explode when the torpedo shall have penetrated to a desired depth in water, earthworks, or the deck of a ship, its action being dependent upon a certain amount of retardation of the torpedo.

Fig. 4 shows, in section, a 67 ton built-up gun of 13½ inch caliber. It shows how it is constructed from sixteen rings or layers of steel, shrunk upon one another. This form of construction and the enormous thickness of wall are necessary to withstand the enormous pressures employed, of 35,000 to 40,000 lb. to the square inch. The gun shown in Fig. 3 is one designed by me for throwing aerial torpedoes. It may be made either from a single casting or a single forged steel tube. You will observe that the diameter of the gun from the rear portion forward one-half its length is the same as that of the 67 ton gun shown in the center, but the caliber of the torpedo gun is 27 inches, twice as great as that of the 67 ton gun; the caliber being doubled at the expense of thickness of the wall, for the two guns, as shown, are of the same exterior dimensions for about one-half their length.

We are enabled to double the caliber, and so materially reduce the thickness of the wall and lighten the

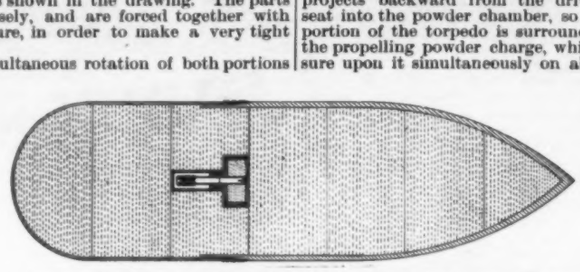


Fig. 1.—MAXIM AERIAL TORPEDO CARRYING ONE TON OF GUNCOTTON.

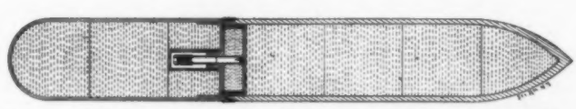


Fig. 2.—MAXIM AERIAL TORPEDO CARRYING 250 POUNDS OF GUNCOTTON.

Fig. 3.—SECTION OF MAXIM 46-TON TORPEDO GUN, SHOWING TORPEDOES CARRYING HALF A TON AND A TON OF GUNCOTTON.

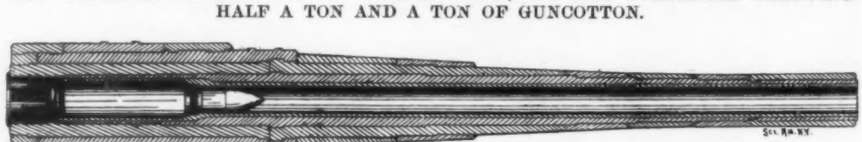


Fig. 4.—SECTION OF WOOLWICH 67-TON GUN WITH ARMOR-PIERCING SHELL.

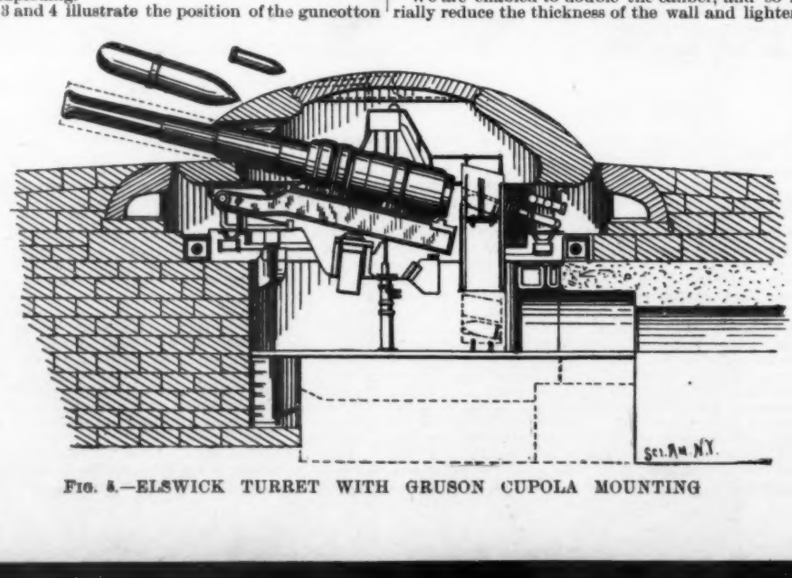


Fig. 5.—ELSWICK TURRET WITH GRUSON CUPOLA MOUNTING

gun, by simply using a pressure of 10,000 lb. instead of 35,000 to 40,000 lb. This innovation is especially desirable in a torpedo gun, because we do not desire to shoot with an object to penetrate armor, and do not care for a flat trajectory; we desire only an equal effective range to other types of guns, and this rarely.

In the torpedo gun we have a caliber twice as great as in other guns, and consequently have four times the area at the base of our projectile. Therefore, with a projectile of equal weight, we can get a higher velocity with 10,000 lb. to the square inch than can be attained with the high pressure guns employing 35,000 lb. These calculations are based upon the assumption that we have equal length of travel of projectile in the gun, and a pressure in both cases equally well maintained behind the projectile; but we have in favor of this torpedo gun and the torpedo projectile the great advantage that, for a gun of equal length, we get a materially increased length of travel of projectile, and by the employment of a propelling gunpowder charge explained further on, which maintains the pressure practically the same to the muzzle, we are enabled to get a much higher velocity for equal weight of projectile than by the other system.

The projectile used in the British 12 inch wire gun is

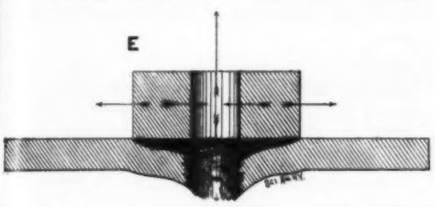


FIG. 6.—AN EXPERIMENT ON THE PHILOSOPHY OF EXPLOSIONS.

three calibers long, and weighs 850 lb. With a propelling charge of 167 lb. 8 oz. cordite, and with a pressure of from 35,000 to 40,000 lb. to the square inch, the projectile is thrown from the gun at a velocity of about 2,350 foot seconds. In the torpedo gun at the top of the drawing is shown a torpedo projectile, carrying 1,420 lb. of picric acid. The total weight of this torpedo will be about 2,700 lb. With a powder charge of 167 lb. Maxim-Schüpphaus torpedo powder, and a pressure of 10,000 lb. to the square inch, and with a travel of projectile in the gun of more than seven and a half feet greater than in the wire gun, the torpedo projectile leaves the gun with an enormously greater energy than that of the projectile thrown from the wire gun; but as the projectile thrown from the wire gun has much greater sectional density than the torpedo projectile, it loses less velocity in overcoming atmospheric resistance. However, this is somewhat counterbalanced with the torpedo gun by a higher angle of fire, so that enormous quantities of high explosive can

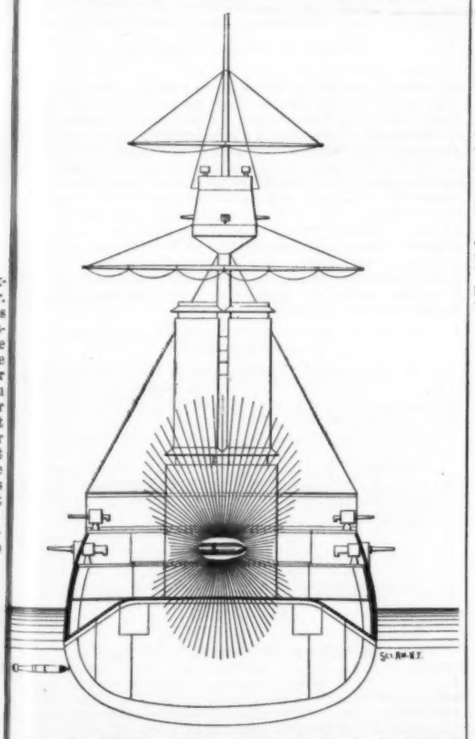


FIG. 7.—EXPLOSION ON BOARD A BATTLESHIP OF THE MAJESTIC CLASS OF A 24 INCH AERIAL TORPEDO.

At lower left is an 18 inch Whitehead torpedo. Black head shows quantity of guncotton carried.

be thrown to a great distance. The torpedo projectile, carrying 1,420 lb. of picric acid, will leave the gun with a velocity of about 2,000 foot seconds, with a range of nearly nine miles. The torpedo enlarged to the dotted lines in front will carry one ton of picric acid, will have a velocity of about 1,500 foot seconds, and a range of about five miles.

The total energy of projection imparted to each torpedo projectile will be practically the same. In the smaller, mass is sacrificed for velocity; in the larger, velocity for mass, so that the total energy of recoil of the gun will be practically equal for each projectile: but as there is somewhat more energy imparted to the aerial torpedo than to the projectile thrown from the wire gun, and as the guns are of equal weight, there will be slightly more recoil to the torpedo gun, but not enough to be a source of any practical difficulty.

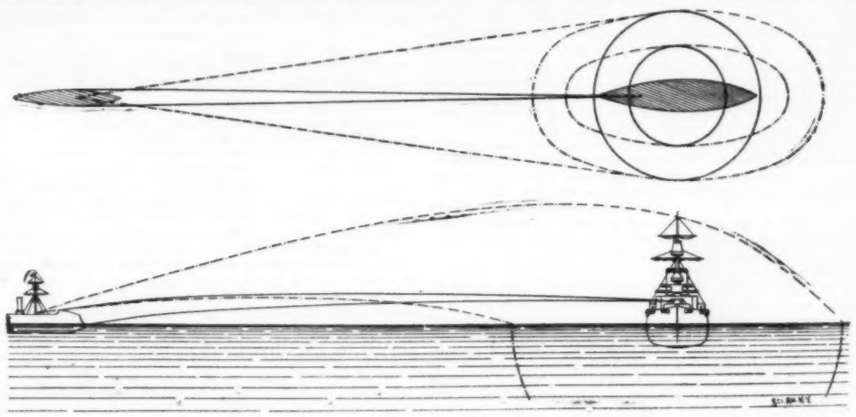
To assist our imagination a little in its realization of the superior destructive energy of these torpedo projectiles above the common armor-piercing shell thrown from the high power guns of the present day, I will call your attention to Fig. 5, which is a section through an Elswick turret with Gruson cupola armor.

We can easily appreciate at a glance the superior efficiency of the torpedo projectile as a means of destroying these steel-inclosed bulwarks. The terrible concussion of the explosion upon or against the armored protection, even if it did not totally demolish the steel wall, would certainly throw the gun out of action and

The maximum effective range of the Whitehead torpedo, carrying 200 lb. of guncotton, is less than one mile, and less than one-fifth the range of the aerial torpedo carrying eleven times the quantity of high explosive. The efficiency of the aerial torpedo is; therefore, more than fifty times greater than that of the Whitehead.

After conducting a very large number of experiments, Gen. Abbot, of the United States army, estimated a pressure of 6,500 lb. to the square inch, great enough to be fatal to a modern battleship; while Lieut.-Col. John T. Bucknill, in his book entitled "Submarine Mines and Torpedoes," concludes that a pressure of 12,000 lb. to the square inch is necessary to inflict a fatal injury upon the hull of the strongest battleships now made.

Five hundred pounds of guncotton will be fatal, therefore, at a distance of about 38 ft.; maximite and picric acid, about 47 ft.; nitro-gelatin, about 54 ft.; one-



FIGS. 8 AND 9.—COMPARISON OF DESTRUCTIVENESS OF A $500,000 CRUISER WITH THAT OF A $5,000,000 BATTLESHIP.

kill all the gunners, to say nothing of the wreck it would occasion elsewhere, especially on board a battleship. It is hard to predetermine exactly the amount of damage which would be wrought by the explosion of half a ton of guncotton, to say nothing of a ton, upon one of the turrets of a battleship, but the destruction, even though not fatal to the vessel, would be very extensive.

In Fig. 6 we have a very curious illustration, indeed, of explosive energy. A cylindrical body of compressed guncotton, with a hole through the center, was placed on a piece of thin armor plate and detonated; the waves of explosion moving in all directons, as indicated by the arrows, and meeting at the center of the hole, are diverted in the direction of the vertical arrows, with greatly increased density and accelerated velocity, thus blowing a hole through the steel plate directly beneath where the hole was in the guncotton, the plate being simply indented beneath the solid portions of the body of the guncotton.

Fig. 7 illustrates the direction of the action of explosion of an aerial torpedo in its transit across the deck of a battleship. The explosive, being tamped by its own weight, and by the resistance of the surrounding air, will react upon the ship's deck with a disruptive effect similar to that of a torpedo exploded under water adjacent to the unprotected side or bottom of the vessel.

We will now extend our comparisons to other systems of torpedo warfare. Of the many types of torpedoes, the most successful have been the Howell and the Whitehead. The Whitehead, standing in the lead, may, therefore, be taken as the best representative of what has been accomplished in locomotive torpedoes.

The Whitehead is a perfect marvel of ingenuity, and the accuracy with which it will travel beneath the surface of the water and strike its target is wonderful. The first torpedoes of this type carried only 18 lb. of dynamite. The quantity of explosive has been constantly increased, and the largest and most powerful to-day carry 200 lb. of guncotton. I will enter into no description of the details or mode of operation of the Whitehead torpedo—a subject so well known—but Fig. 7 will illustrate the comparative sizes of the largest Whitehead torpedo placed alongside one of the 24 inch aerial torpedoes already described, carrying one ton of guncotton.

The tremendous difference in the quantity of explosive carried is very striking, and speaks for the vastly greater efficiency of the aerial torpedo.

half ton of guncotton, about 85 ft.; one ton of guncotton, 168 ft.; while a ton of nitro-gelatin would be fatal at 250 ft. As guncotton is the standard service high explosive in this country, I have given special prominence in the table to the destructive range of this substance.

Figs. 8, 9 are intended to illustrate the destructive efficiency of the blast of high explosives as compared with the smashing effect of the blow given by the bolts of steel or armor-piercing projectiles thrown from high power guns.

Fig. 10 gives an enlarged plan view of the deck of the battleship shown in Fig. 9, with numbers showing the areas of the zones of destruction within the circles drawn about the battleship.

The modern first-class battleship costs about $5,000,000. It carries an armament of four 12 in. wire guns, twelve 6 in., and eighteen 3 and 6 pounders, and five torpedo dischargers. Not more than one-half of the guns can be trained upon a single target at one time. Now, at an equivalent expenditure, we can construct and oppose to this ten torpedo cruisers, costing $500,000 each. This sum will construct a very respectable sort of craft, and one which will carry one 24 in. torpedo gun weighing 46 tons, and two torpedo mortars, weighing 20 tons each. The cruiser would fight head on, and the exposed portion could be protected by deflected armor, sufficiently thick to turn aside all shots thrown from a battleship except those from 12 in. wire guns. The torpedo gun would be capable of throwing half a ton of guncotton nearly nine miles, and one ton about five miles. Each mortar will be capable of throwing 500 lb. four miles, half a ton about three miles, and one ton nearly two miles.

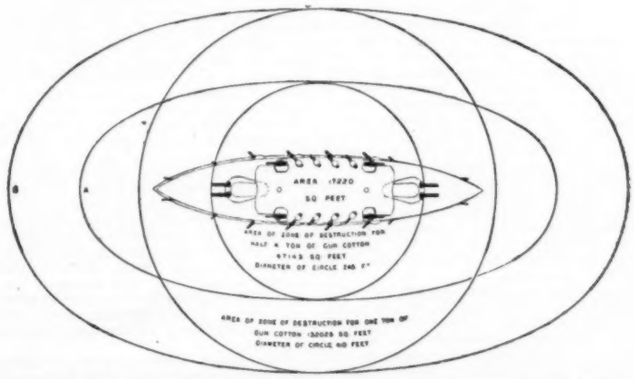

AREA 17270
SQ FEET
AREA OF ZONE OF DESTRUCTION FOR
HALF A TON OF GUN COTTON
67143 SQ FEET
DIAMETER OF CIRCLE 240 FT
AREA OF ZONE OF DESTRUCTION FOR ONE TON OF
GUN COTTON 130025 SQ FEET
DIAMETER OF CIRCLE 400 FEET

FIG. 10.—DECK VIEW OF BATTLESHIP MAJESTIC, SHOWING DESTRUCTIVE AREA OF AERIAL TORPEDO EXPLOSION.

The size of the target presented by the cruiser fighting head on would represent an area about equal to her cross section above that portion protected by the water, while the target presented by the battleship to the cruiser would be in proportion to the quantity of high explosive thrown by the cruiser; and to give an idea of what this really means, there is shown on the right a modern battleship, and on the left a torpedo cruiser of the character just mentioned, pictured in the act of firing upon each other. The full lines drawn from the battleship to the cruiser show the trajectory and angle of fire of the battleship, and also within what a limited angle the fire of the battleship must be confined in order to hit the cruiser at all. The dot and dash lines show the angles within which an aerial torpedo carrying a ton of guncotton would be fatal to

the battleship, and the tremendous size of the target presented by the battleship to the torpedo cruiser. At the top of the drawing is a plan view showing the difference in the areas of the decks of the two vessels. Now, the battleship, in order to do any harm whatever to the cruiser, must, of course, make a hit, and to be fatal, that hit must be made in a vital spot, representing an area much more confined even than that represented by the deck of the vessel. As the cruiser would stand and fight with armored head on, the chance of a hit being fatal would be very small; while every torpedo, carrying from half a ton to a ton of guncotton thrown from the cruiser, and striking the area represented by the deck of the battleship, would at least throw the ship out of action, even if it did not sink her. But, in addition to this, we have the tremendous areas within which such quantities of high explosive, striking in the water, would be certainly fatal.

The lines drawn about the area represented by the deck of the battleship show the distances within which different quantities of guncotton would, according to the table, disrupt or crush the hull of the battleship. Half a ton of guncotton, striking anywhere within the space encircled by the line A, would exert upon the hull the required destructive pressure of 12,000 lb.; and one ton within the tremendous area inclosed by the line B. But, as such a blow upon either end of the battleship, although crushing it, would not necessarily be fatal, on account of the transverse bulkheads and watertight compartments, I have drawn about the battleship two circles, representing distances within which half a ton and a ton of guncotton, respectively, falling, would exert upon the hull of the battleship a pressure of 12,000 lb. in such proximity to her vitals as would be certainly fatal.

The cruiser would have a speed of from 20 to 24 knots, and could, therefore, choose her own position with respect to the battleship. Her tactics would not be like the ordinary torpedo boat, to dash into and run a gauntlet of destructive fire from the battleship, to drop a torpedo and away again out of range; but she would stand her ground and fight, always at a distance and in a position of her own choice, with armored head toward the battleship. In such position the target presented by the cruiser would be very small indeed, to say nothing of the difficulty of inflicting a fatal injury upon such a target with ordinary shot and shell.

The fatal area presented by the battleship as a target to half a ton of guncotton thrown from the cruiser is 47,143 sq. ft., and the fatal area presented to a ton of guncotton is 132 025 sq. ft., and it is a very safe estimate that the area exposed by the cruiser fighting head-on would not be more than one two-hundredth as great as the fatal area exposed by the battleship. Now, as every shot from the cruiser striking within the fatal area exposed by the battleship would destroy her, and as it would take a considerable number of hits from the battleship to sink the cruiser, it is very safe to offset the greater number of shots which the battleship could fire within a given time and the horizontal position of the target presented by her by the superior fatality of the shots from the cruiser. This enables us to very easily approximate the comparative efficiency of the two systems, by simply dividing the average fatal area exposed by the battleship by the area of the target presented by the cruiser. Now, as this area is contained in the area exposed by the battleship at least 100 times, one cruiser would be capable of destroying, on an average, 100 battleships. But we can build ten such cruisers for what it would cost to build one battleship, and we must, therefore, multiply this efficiency by ten. This means that we could, for the cost of one battleship, produce a fleet of torpedo cruisers which would be capable of destroying 1,000 first-class battleships.

These are, indeed, astounding figures. They are, nevertheless, based on such foundation in facts as to, at least, warrant our placing them in a category of practical probabilities.

In the choice of a high explosive for aerial torpedoes there are several desiderata, in addition to the mere force of the explosive. In the first place, it should not be so sensitive to shock or percussion as to be in the least endangered by the sudden force of acceleration exerted upon it in the gun. It must be perfectly stable and undergo no change by time and under varying conditions of temperature. It must be perfectly neutral, having no effect upon the metallic surfaces exposed to it. It should have as high a specific gravity as possible, in order to exert the maximum energy per unit volume. There is one more and very important desideratum, not possessed by any other explosive in like degree as by wet guncotton, and that is insensitiveness to detonation, not only from shocks of percussion, but shocks of ordinary forms of explosion. Guncotton can only be detonated by the explosion of a powerful detonative charge in direct contact with it.

Nitro-gelatin is the most powerful of commercial high explosives, but this explosive is too sensitive for employment in aerial torpedoes to be thrown from guns by gunpowder at high velocities.

Maximite is a title which was first applied to a high explosive invented by me and made according to my United States patent No. 544,924. A stiff nitro-gelatin of the character of that just above described, consisting of about seventy to eighty parts nitro-glycerin and twenty to thirty parts of a very soluble variety of gelatin-pyroxylin, soluble in nitro-glycerin below 100° F., is frozen stiff and then cut into sawdust by a gang of saws. About seventy-five to eighty parts of this explosive sawdust is mixed and thoroughly incorporated with about twenty to twenty-five parts of finely pulped tri-nitro cellulose, the whole being saturated with water. The object of the fibrous tri-nitro-cellulose is to absorb and hold water and lessen the sensitiveness of the compound. The compound may be packed into shells to a density of about 1·4, holding about 15 per cent. of its weight of water, the excess of the water being poured off.

Projectiles filled with maximite may be thrown from ordnance at service velocities with perfect safety. This compound will detonate under the influence of a strong exploder with all the violence of the original ingredients of which it is composed.

Picric acid is a very powerful high explosive, and when melted and cast it has a specific gravity of 1·7. It is highly insensitive to all ordinary influences and is, therefore, exceedingly well adapted for use in aerial torpedoes.

In view of the highly insensitive character of wet guncotton, and the fact that it is as powerful as No. 1 dynamite, to say nothing of the other high explosives just mentioned, it is hard to see the need of air guns if we have a suitable torpedo powder, by which low pressures can be had and maintained and projectiles with thin walls be thrown with safety.

In making a comparison between the system shown you to-day and that of the best system yet developed for throwing torpedoes by means of compressed air, erected at Sandy Hook and San Francisco, in the United States, it may be noted that the caliber of the largest of these pneumatic guns is only 15 inches, while its length is 50 feet and its weight 70 tons. Its maximum range with 500 pounds of high explosive is about a mile and a quarter. The pressure employed in the gun is only about 1,000 pounds to the square inch—greater pressure than this having been found impracticable.

TESTS OF THE STRONG BALANCED LOCOMOTIVE AT PURDUE UNIVERSITY.

THE Strong balanced locomotive, after undergoing successful tests in actual service, was recently sent to the celebrated locomotive testing plant at Purdue University, in order that the results obtained on the road might be corroborated by the more careful methods of the laboratory. This engine, which in its original form attracted more favorable comment from the railroad press than any modern locomotive, has been fully illustrated from time to time in our various publications, and the reader is referred to the SCIENTIFIC AMERICAN and the SUPPLEMENT, respectively for November 14 and 21, 1896, where a detailed description will be found. The following abstract of the report of Prof. W. F. M. Goss, under whose supervision the tests were carried on, is taken from the Railway Age, to which the latter was contributed by Mr. George S. Morison, the vice president of the Balanced Locomotive and Engineering Company.

The locomotive will be recognized as embodying some principles of construction embraced in what was originally known as the Strong locomotive, exploited to a considerable extent over a period of several years beginning with 1887.

Three radical departures from ordinary practice are involved in the construction. These relate respectively to the system of compounding and connecting the valve motion and the construction of the firebox. The last named consists essentially of a pair of tubular shells circumferentially corrugated. The corrugation largely increases the amount of firebox heating surface as well as adding so materially to the strength of the shell that the necessity of staying is obviated. The two corrugated shells which form the firebox proper are brought together at their forward end and united in a single shell, also corrugated, which serves the purpose of a combustion chamber.

The valve motion, which formed a unique feature of the Strong locomotive, has been retained in the present example, but as its working formed no part of the test with which the present report deals, its description is omitted.

The arrangement of the cylinders and connections is not complicated. The two high pressure cylinders are located inside the frames and are connected with cranks upon the shaft. The low pressure cylinders are outside the frames in the position of the cylinders of an ordinary simple locomotive and are connected outside in the ordinary manner. The inside crank of one side is connected at a point diametrically opposite the outside connection upon the same side, and the corresponding cranks upon one side are at right angles with those upon the other side. A full description, with diagrams showing the effect of such construction upon the question of counterbalancing, is contained in Prof. Goss' report, which follows:

A REPORT OF TESTS TO DETERMINE THE CONDITION OF DRIVE WHEEL BALANCE IN "BALANCED COMPOUND LOCOMOTIVE NO. 1." OUTLINE OF TESTS.

In preparation for the tests the engine was mounted upon the locomotive testing plant of Purdue University, which provides: 1, Supporting wheels carried by shafts running in fixed bearings to receive the locomotive drivers and to turn them; 2, brakes mounted upon the shafts of the supporting wheels and having sufficient capacity to absorb continuously the maximum power of the locomotive; and (3) a traction dynamometer to indicate the pulling force exerted by the locomotive wheels. The arrangement of the plant is such that a locomotive mounted upon it may be driven by its own steam at any speed and under any load, the conditions being similar to those of the track.

When the engine had been thus mounted, provision was made for passing lengths of small soft wire under the tread of the drivers while the engine was running at speed, the expectation being that the thickness of the wire as it came from under the wheel would bear some relation to the pressure imposed upon it during its passage. It was thought that if through the action of the counterbalancing, or from any other cause, the pressure of the wheel upon the track should chance to vary as it revolved, the resulting wire would vary in thickness.

That such expectation was reasonable may be inferred from results of similar tests previously conducted in connection with a locomotive which was balanced in a manner now common on all roads. Wires which had been passed under the wheels of this engine not only showed regular variation in thickness, corresponding with definite portions of the wheels' cycle, but when the speed was high, portions of the wire would retain their original section, notwithstanding the fact that they had passed under the tread of the wheel, showing conclusively that the wheel had risen entirely clear of its support during a portion of its revolution.

SUMMARY OF RESULTS.

The results of the tests fully confirm the theory which underlies the design of those portions of the engine affecting the balance of the drive wheels. In the course of the tests wires were repeatedly obtained both from main and rear drivers, while the engine was working at a high speed, which were practically uniform in thickness. A full description of typical wires is given in another portion of this report, and sample wires are submitted. They show that there was little or no variation in the pressure with which the drivers act upon the supporting wheels, and justify the conclusion that the maximum wheel pressure, when the engine is running at speed, is practically no greater than the static pressure due to the weight of the engine; in other words, the so-called "hammer blow," which attends the action of ordinary engines when run at high speed, does not appear in the action of the balanced locomotive.

In discussing the behavior of engines which are balanced in the usual manner, Prof. Lanza, in a paper presented to the American Society of Mechanical Engineers, says:

"There are five different motions which the locomotive (of ordinary type) would receive through the action of the reciprocating parts if free to obey them. They are as follows:

"1. Jerking, or forward and backward motion.

"2. Nosing, an oscillation about a vertical axis through the center of gravity.

"3. Galloping, an oscillation about a horizontal axis at right angles to the track.

"4. Pounding, a vertical up and down motion.

"5. Roll, an oscillation about a horizontal axis."

Without attempting to distinguish between all of these several oscillations, it may be said that experience with testing plants proves that with both eight-wheeled and ten-wheeled engines of the ordinary types, running at speed, the jerking is so severe as to make it difficult to hold the engine under test to its position on the plant, while the nosing action results in a side swing of the front bolster through a distance of from a quarter to three-eighths of an inch, depending upon the speed.

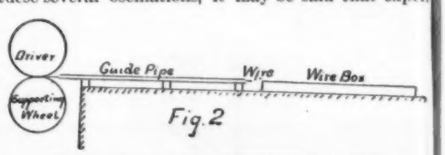


Fig. 2.

METHOD OF INTRODUCING WIRES.

The balanced locomotive, on the contrary, gives very little jerk, and the side swing of its first bolster is not over an eighth of an inch under any condition of speed at which tests were run.

The longer wheel base of the balanced locomotive, as compared with that of the other locomotives referred to, would assist somewhat in holding the engine steady, while, on the other hand, the bolster from which measurements were made is located well out in front of the body of the engine, a position much further from the drive wheels than that occupied by the bolsters of the engines referred to, and one which makes apparent a very slight angular movement.

The conclusion is, therefore, that whatever the speed, the wheel pressure of the balanced locomotive will not vary except as the wheels may be acted upon by accidental forces, as for example impact due to inequalities in the track or changes in the position of the center of gravity of the heavier portions of the machine relative to wheels, through the engine rocking or tipping on its springs. The wheels at all speeds turn smoothly, while the machine as a whole remains almost motionless. Oscillations of every sort which appear in the balanced locomotive are of less than one-half the amplitude of those which attend the action of a locomotive of the ordinary type. It is evident, therefore, that the means adopted to secure perfectly balanced wheels have also served to greatly increase the steadiness of the locomotive as a whole.

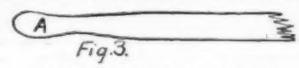


Fig. 3.

FORM OF END OF WIRE.

A DISCUSSION OF COMMON PRACTICE IN BALANCING DRIVE WHEELS.

In an eight-wheeled locomotive of the ordinary type there are connected directly and indirectly with the cranks on each side, a coupling rod, main rod, crosshead, piston rod, and piston (Fig. 4).

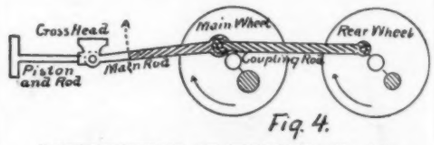


Fig. 4.

DISTRIBUTION OF WEIGHTS TO BE BALANCED.

When the engine is in motion, every portion of the coupling rod follows a circular path, and the effect of the centrifugal forces resulting from it, which alone affect the balance of the wheels, is the same as would result if its place were taken by weights symmetrically disposed about the two crank pins, each weight having half the mass of the rod.

The main rod has different motions at every different point throughout its length. The crank pin end follows a circular path, while the crosshead end moves along a straight line; the effect of this motion, so far as it concerns the balance of the wheels, being the same as that which might be produced by an imaginary rod, one portion of which is assumed to follow a circular path only, and the remaining portion a rectilinear path only. That is, a portion of the mass of the rod such as that upon the right of the dotted line, A, Fig. 4, may be assumed to be simply a revolving mass attached to the crank pin, while the remaining portion may be assumed to partake of the motion of the crosshead only, of which, in effect, it becomes a part.

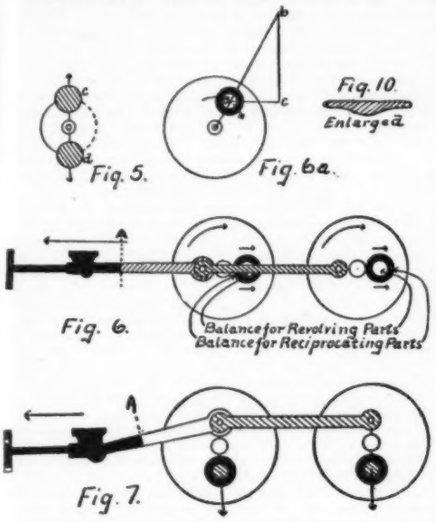
The rotating parts, therefore, which require attention in balancing the drive wheels are the cranks, the crank pins, the coupling rods, and a portion, usually about two-thirds, of the main rod; the reciprocating

parts are a portion, usually a third, of the main rod, the crosshead, the piston rod, and the piston. In Fig. 4 the revolving parts are shaded, while the reciprocating parts are in outline.

A perfect balance of all the revolving parts attached to the pins, and of the cranks and crank pins themselves, may be secured by adding weights to the opposite side of the wheels, the condition for each wheel then being that shown by Fig. 5, in which the masses c and d are assumed to be revolving about the center o; the one representing the masses connecting with the crank pin, and the other the mass of the counterweight. As the centrifugal action of each of these masses is radial, and as the masses are on opposite sides of the center about which they rotate, the system is in perfect balance.

But it is to be noted that all this applies to the revolving parts only. A locomotive in which the counterweights are only equal to the revolving weights (Fig. 4), if used at the head of a train, will act upon the latter by a succession of jerks which will be too severe in their effect to be permitted.

The reason for this will be understood if we consider



ACTION OF EXCESS BALANCE.

the conditions existing in an engine at speed at the instant the cranks are passing the center; that is, when they are in position shown by Fig. 6. At this instant, the radial force exerted upon the crank pin, arising from the motion of the connected parts, is the sum of that due to the rotating parts, plus that due to the reciprocating parts.

To make the engine pass the centers smoothly, therefore, additional weights are put into the wheels, which are shown diagrammatically by the black annular masses in Fig. 6. This portion of the counterweight, which is in excess of that required by the revolving parts, and which is added on account of the reciprocating parts alone, is called the "excess balance."

In the position shown by Fig. 6, the excess balance acts in opposition to the reciprocating parts, and when properly proportioned may hold them in perfect equilibrium; but with a change in the position of the wheel this condition ceases and other conditions appear.

Thus, Fig. 7 shows a change of a quarter of a revolution.

In the new position the action of the excess balance

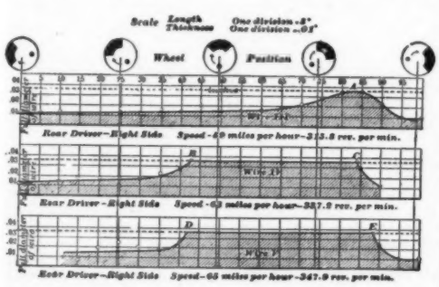

Scale Length One division = 8"
Thickness One division = .05"
Wheel Position
Rear Driver—Right Side Speed - 60 miles per hour - 313.8 rev. per min.
Wire D
Rear Driver—Right Side Speed - 65 miles per hour - 337.9 rev. per min.
Wire E
Rear Driver—Right Side Speed - 65 miles per hour - 347.9 rev. per min.

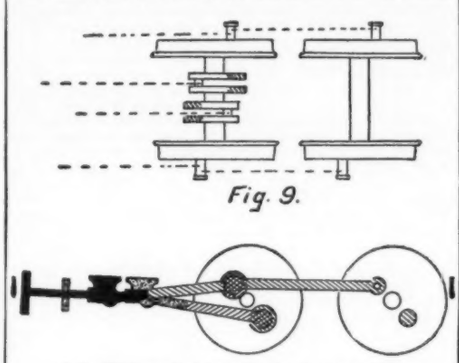
FIG. 8.—DIAGRAMS OF WIRES FROM ORDINARY LOCOMOTIVES.

cannot in any way be opposed by that of the reciprocating parts; and hence, its only effect is to increase the force with which the wheel presses upon the rail.

To make the statement of the whole matter a trifle more technical, but vastly more comprehensive, it may be said that since the counterweights move in circular paths, it is only the horizontal component of the radial force derived from them which can serve to neutralize the effect of the reciprocating parts; the vertical component of all that portion of the force which applies to reciprocating parts, that is, of the excess balance, is unbalanced. This unbalanced vertical component causes the pressure of the driver on the rail to vary with every revolution, its changing value being well illustrated by Fig. 6a, in which a b is the radial force, a c the horizontal component and b c the vertical component, resulting from the rotation of the counterweight about the center o. If the counterweight revolves at a uniform speed, the radial force will be constant, but the value of the components a b and a c will constantly vary, one increasing as the other diminishes.

The Purdue experiments were conducted in a manner similar to those made in connection with the balanced engine already described, and a detailed description of them is presented as an appendix to this report. Fig. 8 gives the actual thickness of some of the wires at different phases of the wheel's motion.

As the result of theoretical research, observation upon the road, and of laboratory investigation, the destructive effects upon track and bridges arising from the presence of the excess balance is now generally recognized; but, notwithstanding this, there have been as yet few attempts to abolish the excess balance, which is the root of the evil. The fact still remains that an engine of the ordinary type pulls its train most smoothly and rides the easiest when the excess balance is equal to the full weight of the reciprocating parts. A common rule allows the excess balance to be equal to 70 per cent. of the weight of the reciprocating parts, and requires that it be equally distributed between the coupled wheels. The present rule of the American Master Mechanics' Association requires that one four-hundredth part of the weight of the engine be subtracted from the weight of the reciprocating parts of each side to find the weight of the excess balance, which



CONNECTIONS OF THE BALANCED LOCOMOTIVE.

must be divided equally among the coupled wheels on each side. If applied to most engines now running, this rule would give substantially the same results as the first one stated; but for the very heavy engines now built, it allows a larger proportion of the reciprocating parts to go unbalanced; a practice which is justified because of the ability of the heavier machines to absorb the oscillating forces developed by the motion of the reciprocating parts before they can be transmitted to the train.

There has been no lack of effort on the part of superintendents of motive power to make locomotives of the ordinary type less destructive to track, but it is very doubtful if all that has thus far been done has accomplished more than to prevent a growth of the evil, as engines have been increased in size and speed.

THE PRINCIPLES UNDERLYING THE DESIGN OF THE BALANCED LOCOMOTIVE.

Referring to the mechanism of one side of the balanced locomotive, there is outside of the frame a low pressure cylinder, the reciprocating and revolving parts of which connect with crank pins in the usual manner. These parts are shown in black in Fig. 9. Inside of the frame, and as close to the low pressure cylinder as practicable, is a high pressure cylinder, the revolving and reciprocating parts of which connect with an inside crank. It is to be noticed that the inside crank is diametrically opposite to the outside crank.

By the arrangement described, all revolving parts are balanced by revolving weights, and all reciprocating parts by reciprocating weights. The following is a description of the manner in which this is accomplished: The rear wheel has only revolving parts connected with the crank pin, and the counterbalance in this wheel is made sufficient for these parts alone. As there is no excess balance in this wheel, the condition of perfect equilibrium is maintained undisturbed.

While the conditions affecting the main wheel are somewhat more complicated, they are nevertheless quite as perfectly dealt with. The revolving parts (Fig. 9), attached to the outside crank pins, are perfectly balanced by the revolving counterbalance in the wheel, and the reciprocating parts attached to this crank pin have absolutely no balance in the wheel. Again, the revolving parts attached to the inside crank are perfectly balanced by revolving parts attached to these cranks. The reciprocating parts connected with the inside crank have no balance in the wheel. That is, the revolving parts attached to the crank pins are in each case balanced by revolving counterweights, which enter into the design of the wheels and cranks. The main wheel has no excess balance.

The reciprocating parts connecting with the outside crank pin are unbalanced, so far as this crank pin is concerned, and the similar parts connecting with the inside crank pin are unbalanced so far as the crank pin is concerned; but these two unbalanced elements are designed to be equal, and, being connected with crank pins which are diametrically opposite, their motion is opposite, and hence they hold each other in equilibrium. One is a balance for the other. As, therefore, the reciprocating parts are completely balanced, there are no forces to "jig the train," and as no use is made of "excess balance," there is no "vertical component" to act upon the wheel and to vary its pressure upon the rail.

These statements are based upon the truth of the principle which appears to be fundamental in the design. As the actual weight of the parts involved is not available, the statements cannot be demonstrated numerically, but the tests already described go to indicate that, having adopted a correct principle, the designer made no mistake in the development of details.

THE EXPERIMENTS.

In carrying out the experiment with the balanced locomotive some difficulty was experienced in guiding the wire between the driver and its supporting wheel—a difficulty due to the fact that the treads of the drivers were coned, while the face of the supporting wheels were straight, the line of contact between them, as measured across their face, being, as a consequence, very short. For this reason it sometimes happened that a wire, which had been started, would roll out from under the wheel, either partially or entirely, and thus present a variable thickness. It is evident, however, that irregularities resulting from this cause would occur at random; that is, they would have no definite relation with definite phases of the wheel's motion, and in making comparison all such wires have been thrown out.

A defect of another sort also appears in some of the wires. It happened that the wires which were first used proved to be so hard that they impressed themselves slightly into the face of the wheels. Wires, which were afterward sent through, occasionally followed at intervals along their length the very slight grooves which the previous wires had formed, and when this occurred the wire is flattened less than at other portions of its length. But there is no occasion for false conclusions from this cause, since in every case the impress of the groove is clearly traced upon the wires, sections containing this defect being similar to that shown by Fig. 10.

THE WIRES.

In the course of the experiments a large number of wires were run under the several wheels experimented upon. Many of these were calipered at 2 inch intervals throughout their length and the dimensions thus formed were plotted to scale.

[The plotted thicknesses of 16 of these wires are given in the report, and the actual wires accompany the report as appendices. The appendices include the following: Wires obtained while the engine was running at a speed of 38·1 miles an hour (190 revolutions per minute); wires obtained while the engine was running at a speed of 49·5 miles an hour (247 revolutions per minute); wires obtained while the engine was running at a speed of 53·9 miles an hour (269 revolutions per minute); wires obtained while the engine was running at a speed of 60·1 miles an hour (299 revolutions per minute); several copper wires, all from the left forward driver, obtained at speeds which were between 55 and 60 miles per hour. In explanation of the comparative diagram, Fig. 11, the thickness of the wires is represented by the distance of the heavy sinuous line from the base, the distances being 50 times greater on the diagram than in the actual wires. The thickness of the wire as plotted as compared with its length as plotted is 600 times greater than the thickness of the actual wire is to the length of the actual wire. These proportions have been chosen for the purpose of exaggerating on paper the variation in the thickness found in the actual wire.—EDS.]

The significance of the results already described is emphasized by comparing them with results obtained in similar manner and under similar conditions from an engine of the ordinary type. Such a comparison is made in Fig. 11. The diagram of the wire from the balanced engine, which appears in this figure, is not shown elsewhere, but that of the wires from the ordinary engine is taken from Fig. 8, changed in scale and as to the direction of wheel motion.

The diameter of the drivers for the balanced engines is 67·4 inches, and for the ordinary engine 62·5 inches, so that while the number of revolutions per minute for the latter is somewhat greater than for the balanced engine, the speed in miles per hour is less. These differences, however, are too slight to impair the value of the comparison. The original wires were, in both cases, of practically the same size.

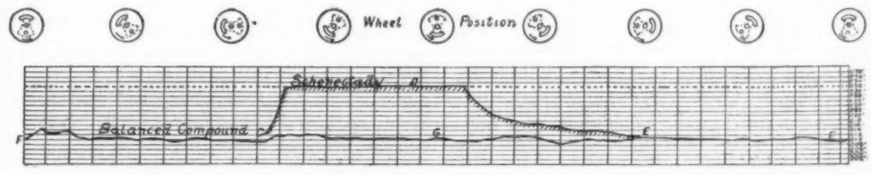


FIG. 11.—COMPARISON OF WIRES TAKEN FROM LOCOMOTIVES SCHENECTADY No. 1 AND BALANCED COMPOUND—DOTTED LINE SHOWS ORIGINAL DIAMETER OF WIRES.

The one important difference in condition is to be found in the fact that the wheel of the ordinary engine carried 400 pounds excess balance, while that of the balanced engine, as already explained, had no excess balance. The result is that while the wire from the balanced engine is nearly of the same thickness throughout, that from the ordinary engine increases in thickness as the counterbalance in the wheel approaches the upper quarter, until its full diameter is reached; a condition which continues through several feet of its length, and makes plain the fact that the wheel must have risen clear of its support during a considerable portion of its revolution.

The conclusions already recited seem, therefore, to be fully justified by the data upon which they are based, which conclusions are, in effect, that the drive wheels of the balanced locomotive are at all times in perfect balance, that they neither increase nor diminish the pressure with which they act upon the rails as they revolve, except as they may be acted upon by accidental

causes; and that all the oscillations of the locomotive are very much less than those which attend the action of a locomotive as ordinarily balanced.

THE STRENGTH OF LADDERS.*

To those who spend a dozen hours a week underground, as well as to the miner with his ten hours a day, the strength of ladders is of great interest, and on occasion may become supreme. To quiet apprehensions on this score, and to furnish a basis of judgment as well, the following tests were made, and if any excuse for them be called for, on the ground of crudity or incompleteness, it will be amply given if others, with better facilities for such tests, be persuaded to take the question up.

The ladders tested were of the common "Bull" pine of the Sierra region ("black pine," Pinus Jeffreyi), the sides of 2 in. × 4 in. rough lumber, fairly clear, and the slats of 1 in. × 4 in. nailed on and not notched in. The width of the ladder and the length of step were 12 in. In such a ladder, when new, the strength of the slats would exceed the resistance of the nails, so that it would fail by the pulling off of the slats. Assuming a vertical position for the ladder, the maximum angle of a man's arm in climbing would be included by 45° out from the vertical, which would also represent the maximum tendency toward pulling off to which the slats would be subjected. In accordance with these premises, the tests were made by placing the ladder at an angle of 45° against a support, with the slats on the lower side, and weighting the slats to the point of rupture or detachment by means of steelyards. The results are shown in the table.

TABLE OF LADDER TESTS.

Ladder.	Age, years.	Condition of wood.	Nails, 10 penny.	No. of tests.	Weight of cubic foot of wood.	Pull.			Remarks.
						Max., lb.	Min., lb.	Av., lb.	
A	New	Green	Wire	3	24·6	886	609	725	Slats all pulled.
B	"	"	Cut	3	24·6	1,524	1,075	1,324	" " "
E	⅓	Very wet	Wire	6	23·2	922	612	759	3 slats broke with warning. 1 " " without warning. 2 " pulled with warning.
C	1	Wet	Cut	5	22·6	1,101	811	979	3 slats broke with warning. 1 " " without warning. 1 " pulled with slight warning.
D	1	Damp	"	7	23·1	1,188	356	721	5 slats broke without warning. 1 slat pulled with warning. 1 side broke " "
G	1	Very dry	Wire	6	25·3	464	226	310	All pulled with warning from 2 to 30 seconds.
F	5	Dry	Cut	2	21·7	665	403	534	1 slat broke without warning. 1 " " with slight warning.
F	3	"	"	3	21·7	1,227	709	987	Made on three-year-old slats on same ladder. 1 slat pulled without warning. 1 " broke " " 1 " " with "
G	1	Very dry	Wire	4	25·3	1,345	1,082	1,348	Made on slats pulled from G. All broke without warning.

Before proceeding to discuss the general strength of ladders as brought out, it will be found interesting to compare tests A and B, made on ladders of identical condition, save in the kind of nails used. The relative resistances of the two kinds, wire and cut, was found to be practically in the proportion of their respective adhering surfaces. Twelvepenny wire nails, 75 to the pound, present an adhering surface of 0·785 sq. in. each, the point being ignored and 1 in. being subtracted from the length to allow for the thickness of the slat. Twelvepenny cut nails, 47 to the pound, with the same allowance present 1·394 sq. in. each. Their relative resistances are 725 and 1,324 lb. for 6 nails, or 121 and 221 lb. per nail, which reduces to 154 lb. per sq. in. of adhering surface for wire and 159 for cut nails.

In studying the table, the column of "Minimum Pull" is the one to which the most interest attaches, and in that the smallest value is 226 lb., corresponding also to the smallest average of 310 lb. The descriptive data for this test, G, are "one year in use in very dry place" and "nailed with wire nails." These would seem to be the ear marks of the poorest ladder. Referring to the last test in the table, it will be seen that the wood was sound, but brittle from its dryness. The failure of this ladder was due to the shrinking or drawing away of the wood from around the nails. Shrinking produces also the same appearance, and to a certain degree the same effect, as if the nails had started from their places; the shrinking of the slat is toward the nail head, which is grasped by the wood, and that of the sides is away from the slat against the resistance of the nail point. And this gives an obvious means of diagnosing this malady of extreme dryness, and one that can be applied instantly to any ladder.

But the case is different for ladder D, probably the most dangerous, if not the weakest one of the lot. A minimum pull of 356 lb., and five slats breaking with no warning, make a very dangerous combination. Casual scrutiny, such as one would naturally give to his surroundings on ascending an unfamiliar ladder way, would reveal the weakness of G, but not of D.

From general appearance F would have been classed as the weakest ladder of the lot, so that its record is surprising, and it is quite worth bearing in mind that prolonged dryness is not the worst condition for timber. Returning to a further consideration of D and G, we should also note that taking into account the foot pressure, G is probably as strong as any in the list. In an average man the chord of his arm, bent in climbing, measures 20 in. from center of shoulder to palm of hand, and 60 in. is the distance from center of shoulder to ball of foot. With the foot placed 72 in. below the hand, the pull of the hand is ⅓ of his whole weight, and the thrust of the foot ⅔ of it. With an assumed weight of 200 lb., the pull and thrust are 55 and 166 lb. respectively. On this basis G presents, as factors of safety, 4 for pull and 6 for thrust; D, on the other hand, presents 6 for pull and 2 for thrust, with the additional danger of no warning before rupture. When we come to inclined ladders, the danger of pulling off becomes less, and G drops from the dangerous list.

The points that stand out from the foregoing are three: The weaker ladder is the very dry one; the most dangerous ladder is the damp one; the strongest ladder is the new one put together with cut nails. As a whole, the study is reassuring, and goes to account for the infrequency of accidents from the failure of ladders. As a corollary the following may be suggested: For dry places use dry lumber and notch the slats in flush; for damp places make heavier slats.

* Written for the Engineering and Mining Journal by Robert Gilman Brown.

THE AUTOMATIC IGNITION OF GAS.

IN commenting on this subject the Journal of Gas Lighting says that devices of various kinds for automatically lighting gas burners have been introduced from time to time; and in a recent number of the Journal fur Gasbeleuchtung, the chemist of the Berlin Gas Works, Herr H. Drehschmidt, has described the more successful of them. He begins by pointing out that the facility with which an electric lamp is ignited and extinguished has been one of the most prominent advantages of electricity over gas for lighting purposes; and he says the stress of competition has compelled attention to appliances for placing gas on an equality with electricity in this respect. It is probable that electricity will eventually come to the aid of gas; but the electrical devices for igniting gas automatically have so far been either large and ugly, or else complicated, and therefore unreliable. Other appliances are at present simpler and cheaper.

In the apparatus devised by Duke, he took advantage of the well known property possessed by platinum sponge of glowing in a current of hydrogen and air. Coal gas contains as great a volume of other constituents as of hydrogen; but these do not excite the sponge. In a mixture of hydrogen and air, the sponge glows with sufficient intensity to ignite the gas; but it does not ignite a mixture of coal gas and air. Rosenfeld showed, however, that coal gas and air caused the sponge to glow to a certain extent, and that a platinum wire attached to the sponge could be thus warmed. It was then raised to incandescence by the gaseous mixture, which it ignited. Rosenfeld's discovery was comparatively useless, because the sponge was found to become dense and inactive by repeated use. Duke, however, made a preparation of platinum to which this objection did not apply. He saturated meerschaum or similar porous material with a solution of platinum chloride, and dried it in a stream of hydrogen or coal gas at a temperature not exceeding 212° F. The platinum was thus reduced and deposited in a very finely divided condition on the material. It may be parenthetically remarked that platinized pumice, similarly prepared by the reduction of platinum perchloride, is well known in this country by users of Harcourt's method of estimating sulphur in gas. Porous material thus coated with platinum, used in conjunction with a projecting thin platinum wire, made a very durable and efficient appliance for automatically igniting a flat flame burner as soon as the gas tap was turned on. A little care was needed in attaching the appliance to the burner in such a position that it was exposed to the mixture of gas and air; and consequently careful handling was necessary to prevent derangement. But with moderate attention, this appliance remained operative for a long period. Ammonia and sulphureted hydrogen and vapors of carbon disulphide temporarily destroyed its activity.

The appliance was not so readily adapted to incandescent gas burners, and the first attempts to utilize it were unsuccessful. If it was suspended from the rim of the chimney, or attached to the top of the mantle fork, so that it was immediately above the mantle, it was subjected to the action of the hot gases from the flame, and was injured thereby. If placed above a pilot jet at the side of the mantle, some means of extinguishing the jet as soon as the burner was lighted was needed; and a tap which provided for this required in practice such careful manipulation that its general employment was out of the question. It was essential to success that a simple turn of a tap should complete the operation; and the patent taken out by the Greek Canellopoulos, which has been acquired by a company in Berlin, first described a means of accomplishing this result. According to the specification, an abstract of which recently appeared in the Journal, the flame of the burner heats a solid, liquid, or gaseous body in such a manner that the supply to the pilot jet is thereby automatically cut off so long as the burner itself is in use. One method of achieving the object of the inventor was to take advantage of the expansion of a confined volume of air in a tubular chamber set up near the mantle. The lower end of the tube was sealed by mercury, and the expansion of the confined air by the heat of the burner flame forced the mercury up the small gas pipe which fed the pilot jet, and thus cut off the flow to the latter. The supply to both burner and jet was controlled by one tap, and therefore on opening the latter the gas flowed to both simultaneously. The pilot jet was ignited by means of Duke's device, as described for flat flame burners; but before the flame could be communicated to the burner, a considerable quantity of gas had flowed out, and formed an explosive mixture within the chimney. The ignition of this mixture by the pilot jet injured the mantle.

It was therefore necessary that the gas should only begin to flow to the burner after the pilot jet was already ignited by means of Duke's appliance. The firm of Ludwig Loewe & Company made an improved apparatus, also depending on the principle of expansion as set out in the patent of Canellopoulos. They, however, used a platinum wire in place of confined air as the expanding body. The platinum wire was suspended from a hook alongside the mantle, and adjacent to the flame of the pilot jet. Its lower end supported one end of a lever, the other end of which was attached to the plug of a two-way valve on the gas pipe. When the wire was cold and taut, the plug was held so that it closed the way to the burner, and left open that to the pilot jet. If then the gas tap was opened, the gas only flowed to the pilot jet, and was there ignited by Duke's device. Then the heat of the flame of the jet slightly expanded the platinum wire, and thus the way to the burner was slightly opened. The gas which then flowed from the burner ignited from the flash light, and the heat of the burner flame further expanded the wire. The way to the burner was thus opened to its full bore, while that to the jet was completely closed, and the light extinguished. This appliance, of course, depends for primary ignition on the proper action of the platinized meerschaum and the platinum wire as used by Duke; and it therefore fails with oil gas or other gas that contains little free hydrogen.

After the extinction of the burner, a short time must elapse before re-ignition is attempted, as it is essential that the platinum wire which operates the valve should be cold when the gas is first turned on. On account of the slow flow from the pilot jet, the distance from the tap to the burner or burners supplied should not be more than about 25 feet. If it is more, the interval of time between turning on the tap and ignition is very great. One tap may control several burners, provided each is fitted with the device for automatic ignition.

AMERICAN HORSES FOR GERMANY.

THE following has been received from Vice-Consul Simon, dated Hanover, June 1, 1897:

For about two years efforts have been made to introduce American horses into Germany. At first great difficulties had to be overcome. The accommodations on the ships were not good; a large percentage died during the voyage, and the rest arrived in such bad condition that the whole lot had to remain in quarantine for several weeks. The freight and other expenses of transportation were high, and last, but not least, the horses were not the kind needed in Germany and hence were not sold at profitable prices. Now, however, some ships of the Hamburg and Bremen lines are fitted out expressly for this service. The freight is lower—$25 per horse, I am told—and the man attending the horses is taken over and returned free of charge. The accommodations are so perfect that the horses arrive here in good condition. The loss on the voyage is reduced to from 2 to 4 per cent. The result is they are permitted to be landed without quarantine. The number of horses sent to Hamburg is much larger than the number sent to Bremen. The unloading at the former port is more convenient, as they can go from the ship directly to the pier, while in Bremerhaven or Nordenhamm, the ports for the larger Bremen steamers, the horses have to be lightered ashore.

The American horses which sell most readily in the German market are thickset working animals of the Percheron breed, with short, specially heavy legs. Until lately, this variety was mostly imported from Belgium. The home demand there, however, has become so great that horses of full growth are at once bought, leaving only young colts to be exported. Danish horses, large numbers of which are imported into Germany, are used for tramways and stages; they are not so heavy as the Percheron breed.

The hoofs of the American horses lately imported are pronounced better than those of the Belgian horses.

Buyers of American horses have made two complaints: They say that the animals, not being accustomed to the food generally given to horses in this country (oats and wheat bran), lose flesh, and that it is several months before they are again in good condition. If American breeders who intend to export horses to Germany should feed the animals some months before they are shipped, as well as on the passage, with oats instead of corn, the animals would remain in good condition. Buyers further complain that the majority of the horses are not broken to harness.

American horses have been sold here lately at prices ranging from $225 to $300 a head.

The demand in Germany is, next after the class above named, greatest for showy, high-stepping horses, in contrast to the American fast trotter; the supply has of late come from Hungary.

Hanover at one time was pronounced to be the best horse market in Germany. It has since lost that standing, though it would be well for importers by way of Hamburg or Bremen to keep an eye on this market.

Army horses are almost exclusively raised in Germany, being bought when young—two to three years old—and kept in the several supply stations (Remonte-depots) until fit for service. They are regarded as needing at that age a special diet; the training, on the other hand, is given in the various regiments, a year or somewhat less being allowed for this purpose.

ENGINEERING NOTES.

Stiffened cement has been used successfully in the construction of a boat by an Italian named Gabellini. The frame is of steel bars a third of an inch in diameter, over which is spread a wire netting. On this the cement is laid and the outer surface is polished. The boat is heavier than one built of wood would be, but is cheaper and slips better through the water. Experiments have proved its strength.

The following are the compositions of some of the most prized of the Japanese copper alloys: 100 parts of copper with from 1 to 10 parts of gold constitute the varieties of shadko, which is colored bluish black with copper sulphate, alum and copper oxide. The gray guishibuishi contains, besides copper, some 30 to 50 per cent. of silver. Sinchu, the best Japanese brass, consists of 100 parts copper, 50 parts zinc, and lastly a bell metal is made up of 100 parts copper, 15 parts zinc, 40 parts tin, and 5 parts of iron.—Prometheus.

The three new steamers built for the Japanese line Toyokisen Kaisha by English shipbuilders are of a construction hitherto unknown in Eastern Asia. They differ from the twelve boats building now for the Nippon Yushee Kaisha in this respect, that they are passenger boats, while the twelve are freight steamers. The speed of the three new steamers is to be 17½ knots per hour, so that they will be faster than the boats of the Canadian Empress line, to the present time the fastest and most comfortable line in those seas. The journey across the Pacific will take twelve days, as against seventeen, which is the present length of the trip.—Uhland's Wochenschrift.

The following paragraph seems familiar—rather more familiar than the steel: We know that "wootz," or Indian steel, was one of the items of the tribute paid by Porus to Alexander the Great. This much prized metal the patient Hindu still produces by his primitive methods, and in a crucible no larger than a chimney pot, over a rude clay furnace fanned by a goat skin bellows, fuses from the ore a small "bloom," or lump of steel, of a quality unattained by European metallurgy. The fuel used is very pure charcoal, and in the crucible is put some chopped wood of Cassia auriculata with green leaves of Convolvulus laurifolia and of the ak or medar (Calotropus gigantea), a large Asclepiad. Thus was produced the raw material of the famous Damascus sword blades, and from it native armorers still forge weapons of the finest temper, and possibly drills as hard as Mr. Maxim's.—Delhi Morning Post.

The English firm Armstrong & Company has built to order of the Russian government a powerful steamer of peculiar construction. It is intended to ferry passengers and freight of the Trans-Siberian railway over the Baikal lake. Since that lake is covered with ice several feet thick during a considerable period every year, the boat is built so as to be able to break through the ice. At the beginning of 1896 the order was given, and in June of the same year the hull of the vessel was already completed and taken apart again for transport. This undertaking is unique in its kind—a ship of 4,200 tons built in less than six months, taken apart, packed on an ocean steamer, and sent to St. Petersburg. From there it was transported to the terminus of the Siberian railroad, and thence to its destination by sledge. The putting together of the boat was superintended by an engineer appointed by the Russian authorities, and acquainted with the art of shipbuilding.—Uhland's Wochenschrift.

The resistance to fire offered by wrought iron pillars recently engaged the attention of a commission appointed by the Hamburg Senate. The report just issued states that such columns withstand fire very imperfectly, their stability being quite destroyed at a temperature of about 600° C., and the advantage of filling them with concrete is very slight. The case is, however, far different with outer coatings of refractory or non-conducting materials, which have proved capable of protecting the metal from a dangerously high temperature during a certain space of time, and, consequently, of affording effective protection against fire. The substances which appear to have exerted the best effect are the cork composition of Herren T. Ganzweig und Hartmann, and xylotile incased in sheet iron, which substances give out inflammable gases for two hours and a half, leaving a carbonaceous residue that is not destroyed by the steam from the fire hose. A pillar thus coated only gives way after being exposed to the fire for four hours, while seventeen minutes suffice to destroy it if uncoated when similarly heated. Next to the above named substances comes the Monier concrete, laid on in a coat of 1½ inch thickness, which preserves iron for nearly two hours and a half, while plaster of Paris and asbestos cement only gave poor results.—Invention.

The story of a remarkable engineering feat in California is told by the Chicago Railway Review. A great section of mountain was recently torn off by 10,000 pounds of powder, lifted several feet straight up and then pushed bodily forward 40 or 50 feet, trembling over the gorge below the dam and then falling with an awful roar 125 feet, to remain hereafter for all time as the bulwark of the great dam being built to impound water for the city of San Francisco. The dam is 43 miles east of the city. For two months or more preparations had been made for the monster blast, in common with another blast that is nearly ready. The plan was to cut tunnels into the side of the mountain at various points above the bed of the creek and to place in these tunnels first great stores of black powder, which ignites slower than giant powder, and, therefore, it has more pushing power and less shattering effect. On the surface and in places through the mountain side were placed big deposits of giant powder for the purpose of shattering the mass and lifting it up. According to plans, the black powder when it exploded would hurl the mass straight forward, making a bridge of granite across the gorge and blocking the stream. The plans were carried out with the greatest care and with a successful result. When the dust cleared away, it was found that the blast had dislodged a mass of rock 400 feet up and down stream and an average of 60 feet in height, completely bridging the canyon. The engineers estimated that the amount dislodged weighed about 150,000 tons. The rock was thrown exactly as the engineers had planned.

ELECTRICAL NOTES.

The steam tramway from Cassel to Wilhelmshöhe has been bought by Siemens & Halske, and is henceforth to be replaced by electrically propelled cars.—Uhland's Wochenschrift.

An improvement that should prove useful on diving dress is a telephone transmitter attached to the helmet, placing the driver in direct communication with his helpmates above.—Revue de l'Electricité.

A second submarine cable was laid from England to France on May 8. It strikes the British shore west of Dover, and France west of Calais. A third cable is going to be laid by the French Government.—Revue de l'Electricité.

In England the total number of subscribers on the telephone lines was 9,000 in 1895, and increased to 13,000 in 1896. In the same year fifty-nine supplementary offices have been opened, and the total number of communications has risen to 350,000,000.—L'Electricien.

In July of this year boats propelled by electricity were experimentally run on the Spree, at Berlin. The elegant boats are built by the Hagener Accumulatorenfabrik, and carry 30 passengers. They effect a communication between the Exchange and the Richard Wagner Strasse. There will be five stopping places, and the whole fare will be 10 pfennig, i. e., about 2½ cent.—Uhland's Wochenschrift.

A writing pen provided with a small electric lamp has lately been patented in Germany and Austria. By this device it is said that the paper in front of the writer is kept well lighted, the disagreeable shadow of the pen being altogether done away with. The invention would scarcely seem simple enough to come into general use; how such a pen would work in the dark can be found out by trial only.—Wiener Gewerbe Zeitung.

The Russo-Belgian Electrical Company has recently obtained, jointly with the Helios Company, of Cologne, and the Russian Lighting Company, at St. Petersburg, the sole right of laying in the Russian capital cables for supplying private houses with electricity for lighting purposes. This concession implies enormous privileges. The share of the Belgian company alone comprises the installation of 100,000 lamps.—L'Énergie Electrique.

In fairly strong rain the moistened surface of the earth may be used as a conductor for telegraphic purposes; a double conducting system, i. e., a whole circuit, may sometimes be obtained by using for one conductor the surface moisture, and for the other the well water under ground. It seems, however, the experiments made in this direction can have no practical application, as the connection can only be used under rare circumstances.—Prometheus.

A block signal system has been tried in the great thoroughfares of London (England). The contrivance consists of a high mast, on which the police officer in charge may at will hoist a sign with the word "stop." At night the signal is lighted by electricity. The arrangement is simple, and seems to work very well. It ought to prove very useful not only in preventing dead-locks in the traffic, but also in opening a path for fire engines and public processions, etc.—Uhland's Wochenschrift.

It has often been noticed that high chimney stacks are only rarely struck by lightning. By statistics, such exceptional cases occur three times in 10,000, while steeples are struck 60 times, windmills even 80 times out of the same number of cases. The fact is explained by the discharge which the ascending smoke continually keeps up. In some places it is customary to light a big fire on the approach of a thunderstorm. The origin of this may lie in the same quarter.—Der Stein der Weisen.

At the Victoria Station, Manchester, England, baggage to the weight of 1,500 lb. is transported by a combination of suspended electric cars and electric elevators. The work is done with wonderful rapidity and has, so far, led to no accidents or disorder of any kind. On account of its simplicity, speed and safety this system should prove extremely useful, and worth being adopted in other places where heavy weights are transported over short distances.—Monatschrift für Oeffentlichen Baudienst.

The lead fuses of Fischer-Hinnen recall the magnetic blow-pipe and the lightning arrester of Siemens & Halske, which quickly interrupts any arc. According to the description, apparently by its inventor, in Eclairage Electrique, the fuse wire is wound in the deep grooves of a porcelain bar; the grooves are sharp-cornered, and have a depth of one inch. The porcelain is hollow, and contains a soft iron core with pole plates above and below. At the lower extremity is a terminal from which the spiral lead wire starts; the other end of the lead wire is attached to the upper plate, so that the current returns through the iron core and the pole plates. A long fuse can thus be applied, and the winding of the wire around, though in series with the iron core, makes the iron an electro-magnet, which blows out any arc formed. The one test mentioned is not particularly convincing, but the fuse, if not too heavy and cumbrous, may well answer its purpose.

The following statistics, giving the number of motors connected to the mains of the Berlin Electricity Works, have just been published, says The Engineer: In all 1,698 motors are connected, aggregating 6,110 horse power. Of these, 372, corresponding to 1,379 horse power, work presses; 333 motors, or 1,960 horse power, are used for lifts; 226 motors, or 177 horse power, for ventilators; 186 motors, or 645 horse power, for machine tools for metal working; 77 motors, or 311 horse power, for woodworking machines; 74 motors, or 293 horse power, for grinders and polishers; 62 motors, aggregating 197 horse power, are used in paper works; 57 motors, or 192 horse power, for sausage machines; 21 motors, or 20 horse power, are used by color manufacturers; and 16 motors, or 25 horse power, drive sewing machines. In addition to these are 29 washing machines, 13 ironing machines, 11 leatherworking machines, and 13 machines for electrotyping purposes, aggregating 43 horse power; 3 motors, or 63 horse power, for driving dynamos, and 205 motors for various purposes, requiring together 636 horse power.

SELECTED FORMULÆ.

Bug Exterminators.—Below follow a few formulas for bed bug exterminators, as recommended in various quarters:

Benzin Compound.—

Colocynth	5 g.
Insect powder	5 "
Benzin	100 "

Buchheister's Bed Bug Exterminator.—

Tobacco	100 g.
Insect powder	100 "
Carbolic acid	75 "
Boric acid	25 "
Oil citronella	4 "

Borosalicylic Solution.—

Sodium borosalicylate	20 g.
Water or quassia decoction (5:100)	100 "
Spirit lavender	50 "

Picric Acid Mixture.—

Picric acid	5 g.
Stearic acid	10 "
Paraffin	10 "
Oil clove	5 "
Kerosene	250 "

Hager's Bed Bug (Paste) Powder.—

Persian insect powder	100 g.
Pellitory	100 "
Carbolic acid	5 "
Oil citronella	5 "
Dilute alcohol	enough.

Make a thin paste, which is to be brushed into the cracks.

A heroic remedy is the following, recommended some time ago in the SCIENTIFIC AMERICAN, viz.:

Arsenic	2 ounces.
Corrosive sublimate	¼ "
Venetian red	¼ "
Lard	13 "

The next is also from the same source, but is indorsed no more than the preceding:

Corrosive sublimate	1 ounce.
Muriatic acid	2 "
Water	4 "
Decoction of tobacco	16 "
Oil of turpentine	16 "

Liquid bug exterminators are usually applied with a brush, but a much better method is to employ a machinist's oil can, a fair substitute for which is a bottle in the perforated cork of which is inserted a quill.

A few words about the bed bug itself may not be inopportune. The cimex, or more properly acanthia, lectularia belongs to the division of insects known as hemiptera (half-winged), subdivision heteroptera (dissimilar-winged), although few people suspect that they are first cousins to the equally vengeful mosquito. Heteroptera are characterized by two dissimilar pairs of wings, but in the house bug these wings are wanting or extremely abortive. Blood is not their sole nourishment, but in case of necessity they content themselves with various vegetable juices; however, they can live a very long time without food, when they become almost transparent. The female is supposed to deposit its eggs—about 50 at a time—in the alternate months of March, May, July and September, the young brood requiring eleven weeks to mature. The vigorous individuals of the September series live through the winter, the greatest cold being unable to kill them.

Aristoteles taught that house bugs are generated in the perspiration, but they are supposed to have been introduced from India. In the latter country they must surely be luxuriating, since in hospitals a bug trap is a necessity, this trap being a board full of minute bore holes which is placed beneath the mattress, whence it is removed from time to time to be scalded. —Western Druggist.

Plating Aluminum.—To plate aluminum with gold, silver or nickel, by the galvanic process, it is necessary to first coat the article with a covering of copper. This is best done as follows: First wash the metal thoroughly in a solution of soda, then carefully remove all the soda by immersing the article in running water; next place it in hot hydrochloric acid, diluted to contain 5 per cent. of acid. Wash again and put into copper sulphate solution, slightly acidulated. When a thin cover of metallic copper has formed, the aluminum is ready for galvano plating—but must first be washed.—Wiener Gewerbe Zeitung.

Liquid Starch Gloss.—

Distilled water, fluid measure	100 parts.
Borax, by weight	10 "
Gum arabic, by weight	10 "
Spermaceti wax, by weight	10 "
Glycerine, by weight	27 "
¼ per cent. oil of lavender.	

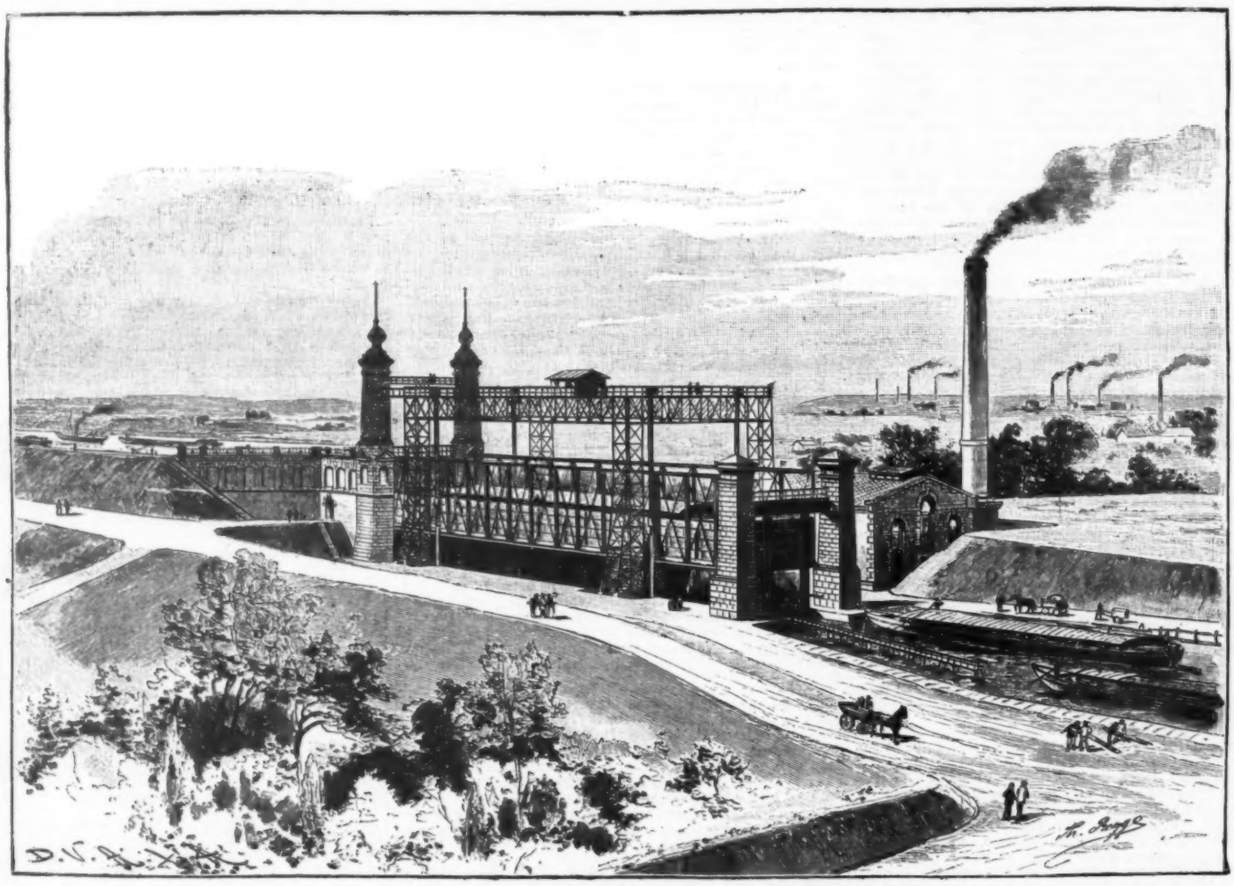
Dissolve the borax in water, and then dissolve the gum in this solution, and gently warm it sufficiently to dissolve the wax. Then put the whole into a warm stoneware mortar, and rub up the whole until the wax has emulsified, i. e., formed a creamlike emulsion, with the fluid. Then gradually add the essential oil, and finally stir in the glycerine, being careful to stir all the while it is being added, so as not to cause the separation of the components. Some little skill is required in forming an emulsion, for, if not properly done, the ingredients will separate on standing or on the addition of water. In a properly formed emulsion no such separation will occur. One secret of success consists in stirring the mixture always in one direction, say from left to right. Never reverse the stirring process, or you will assuredly cause separation of the constituents. Another secret is to maintain the temperature constant until the last morsel of wax has entered into combination—it is only a physical, not a chemical one—with the other ingredients. In the last formula the glycerine may be dispensed with if desired. The directions for use are to be: One teaspoonful of the liquid gloss added to each point of boiling hot starch made in the usual way, and the fabric starched in the usual way. Or the linen may be first starched in the usual way with plain starch, and then a rag dipped in the gloss, squeezed out, and lightly smeared over the starched portion, and the ironing proceeded with as usual.—Pharmaceutical Era.

THE DORTMUND-EMS CANAL.

OF all Germany, Westphalia is one of the most favored provinces. In the east and north fertile fields and rich orchards extend far and wide over the land, liberally yielding their treasure, while in the mountains that rise from the banks of the Sieg and Ruhr lie hidden coal and iron, the foundations of industrial prosperity. The valley of the Sau, on the other hand, the Switzerland of Westphalia, delights the traveler with its vast oak forests and pine woods. Nature has greatly blessed the country, but one thing it has been denied: no great river pours its crystal wave through the land, opening a path whereon the merchant vessel may carry the riches of the land away over buoyant waters to the northern market. But where the hand of Nature has not provided, man's skill must be called to aid. For years it had been purposed to build a canal to connect the industrial center of Westphalia with the North Sea. Only lately this plan came into execution, some forty years after its promulgation, forty years which must have caused a large pecuniary loss to the German province. At the present time the great canal is completed, and henceforth, no doubt, Westphalian industry will flourish more than ever.

A silver streak, the Dortmund-Ems canal, extends from east to west through green meadows and dark forests, here and there with a pretty cottage reflecting in its waters. The mountainous nature of the soil has in many places called the engineer to work. Numerous bridges and viaducts cross the canal.

The Lippe bridge at Oelfen, in particular, is a masterpiece of engineering. It is nearly 49 feet broad and 227½ feet long. Many obstacles had to be removed, many structures to be erected to render the plan of a canal practicable. The most imposing and the greatest of such is the one we give an illustration of. At Heinrichenburg the level of the canal changes by some 45 feet, and the transferring of the barges from one portion to the other is contrived by an ingenious elevator system. It will give our readers some idea of the vastness of the machinery if we mention that the length of the moving reservoir for the barges is 245 feet. Our illustration shows it lifting a barge, the work being just half completed. Under the reservoir there are five floats, which are firmly attached to the reservoir by steel beams, and which are wholly immersed in water. The upthrust of the floats is exactly equal to the pressure due to the weight of the reservoir, etc., so that a small force is able to lift reservoir and barge to the higher level. This giant structure is remarkable as the greatest and, technically, most perfect of all similar mechanisms in the world. Our illustration is taken from Ueber Land und Meer.



THE SHIP ELEVATOR AT HEINRICHENBURG, ON THE DORTMUND-EMS CANAL.

THE UTILIZATION OF ALUMINUM IN THE ARTS.

UNDER the above title Alfred E. Hunt, president of the Pittsburg Reduction Company, delivered before the Franklin Institute, Philadelphia, a lecture from which the following excerpts are taken.

Until within ten years it was believed that if any one should be fortunate enough to produce aluminum so as to retail it at $1 a pound, the consumption of the metal would be enormous; and that if it could be sold at fifty cents a pound, the demand for the metal would be prodigious.

Early in the progress of the Pittsburg Reduction Company my attention was called by the necessities of the case to the fact that the problems connected with the sale of aluminum, its adaptability for various purposes and the progress of the utilization of the metal, were as intricate as the problem of the cheaper production, and required as much research, offering a great many more opportunities for remuneration than would the search for cheaper methods of production. The perfecting of details in the higher processes as carried on at Niagara Falls, Pittsburg and Kensington have already allowed the aluminum to be sold at 31 and 32 cents per pound in ingots, while the relative price in sheets over ingots is not greater than that charged for copper and brass. Copper sheet has a specific gravity of 8·93; brass sheet, 8·15 to 8·20; aluminum sheet runs 2·62 to 2·66; so that copper is $3\frac{4}{10}$ times and brass $3\frac{1}{10}$ times heavier than aluminum.

The output of aluminum in the United States in 1896 was about 1,300,000 pounds, and the output for 1897 will be about 2,000 tons; and I estimate a consumption of only about 1,000 net tons in the United States.

The uses of aluminum have enlarged very much in the past eight years; and from a consumption of not over 100 pounds per annum and selling at not less than $8 a pound, it has increased to 100 tons in 1896.

One of the most important uses of aluminum has been its utilization in the manufacture of steel ingots and steel castings. Many attempts have been made to alloy aluminum with iron and steel; but no very satisfactory results have been so far obtained. The influence of aluminum seems to be as a softener rather than a hardener of iron. Aluminum combines with iron in all proportions; but an alloy of 50 per cent. aluminum and 50 per cent. of iron, while casting into a solid mass, will crumble into powder in a very short time. Aluminum is largely used in the manufacture of steel; but the amount is very small and varies with the steel being made, the amount of occluded gases and the temperature of the molten metal. It is put into the ingot mould, or groups of moulds, until the proper proportion has been determined, starting with two ounces to the ton of steel and increasing to four or five ounces to the ton, according to the result desired. Bessemer steel requires one to three ounces more per ton than open hearth metal to produce the same effect. The special advantages to be gained by the use of aluminum in steel manufacture are as follows: First, increasing the soundness of the tops of the ingots, with consequent decrease of scrap (saving loss); second, quieting the ebullition in molten steel, thereby allowing the successful pouring earlier than otherwise; third, adding to the homogeneity of the steel by preventing oxygenation, also by decreasing the time the steel will remain fluid after being poured into the moulds, preventing the central core from hardening longer than the outside portions of the metal. It increases the tensile strength of the metal without decreasing the ductility.

Good steel has been made, using aluminum entirely, instead of manganese. The use of aluminum insures smooth surfaces in castings and ingots. Its use increases the soundness of the fibers of steel ingots and decreases the scrap and other loss. This use of aluminum in the manufacture of steel is adopted almost universally with the principal steel manufacturers, not only in this country but in Europe. The phenomenon of quieting ebullition is a very important one. Steel would ordinarily boil from ten to fifteen minutes before freezing over; and when freezing would rise from eight to ten inches, if ordinary steel, unless something heavy were placed on the top of the ingots. When aluminum is added, the steel will freeze over within thirty to forty-five seconds. There is danger of adding too large a quantity, in which case the metal would form too solidly and create deep pipes in the ingots; the shrinkage due to contraction producing pipes occasioning a serious amount of crop ends. No difficulty has been experienced with mixing aluminum with steel, as it seems to thoroughly permeate the metal without any special stirring.

Prof. Arnold has shown that the blow-holes in steel are primarily caused by carbonic oxide in the metal. Aluminum is the principal deoxidizer known to metallurgists, the next being silicon. One hundred parts by weight of oxygen will combine with fourteen parts of aluminum or 350 parts of manganese. This does not correctly express the deoxidizing power of aluminum; as it has such a great affinity for oxygen that the latter will entirely disappear where aluminum is present. There is also an additional inducement to use aluminum; for the silicon will add about $1 to the cost per ton of steel, while aluminum will not add over 10 cents to the cost per ton.

Some manufacturers use ferro-aluminum, this being a trade name given to 5, 10, 20 per cent. alloy with iron. Most users of ferro-aluminum make their own ferro by adding known weights of aluminum to known weights of steel cast in convenient moulds. In cast iron, one to two pounds of the metal is put into the iron as it is being poured from the cupola into the melting furnace. Where there are difficult castings to be made, or where the iron will not flow well, aluminum certainly, in many cases, has allowed of better work being done and stronger and sounder castings being made. The effect of aluminum in wrought iron is not very marked. It seems to add somewhat to the strength of the iron, but the amount is not sufficient to induce the general use of aluminum for this purpose.

Aluminum, either pure or alloyed, is sold upon the market by the dealers now in the form of ingots, bars, plates, sheets, rod, wire, tubing and castings. Among the alloys, there are several kinds of purposes for which it is to be employed. The principal hardeners are copper, nickel, zinc, manganese, titanium, tungsten and vanadium. It has been found practicable to combine several of these metals in the different forms, rather than using them singly to form alloys.

The ordinary commercial aluminum contains over 99 per cent. of pure aluminum. Casting aluminum can be very much improved in rigidity and tensile strength if afterward subjected to drop forging processes. One of the particular uses of aluminum at the present time is in the fabrication of aluminum cooking utensils, for which it is well adapted by reason of its lightness, resistance to corrosion, ease of keeping clean, and high specific heat. It is made up in the form of cast hollow ware and stamped or spun.

In shaping aluminum wares better work can be obtained by the stamping process. The spinning operation being of such a character as to spread apart the metal, a much more open surface for corrosion is exhibited than when stamped.

One of the great advantages of aluminum is that the salts occasioned by its corrosion are not in any way

poisonous. It may be kept clean from corrosion by the same care bestowed on brass or other bright work.

Pure aluminum is not as readily corroded as the alloys of the metal. With imperfectly made aluminum there is sometimes metallic sodium alloyed with it. Its presence occasions rapid corrosion, that is, corrosion of the sodium in the aluminum, leaving the aluminum of such porous character that it corrodes much more rapidly.

Aluminum is receiving extended use in chemical laboratories, in water baths, Bunsen burners, hot water filters, and condenser tubes.

(To be continued.)

ELECTRIC PLOWING.

OUR grandfathers plowed with oxen and horses, and at that remote epoch in which the railway and the telegraph had not as yet perturbed the existence of farmers they derived much benefit from this slow but sure process of labor, the traditional character of which flattered their conservative instinct. But, with the progress of the transportation industry, competition made its appearance, and it became necessary to recognize the fact that animal power was not everywhere and always the most economical and rational as regards plowing. So the larger cultivators have had no hesitancy for the last thirty years in having recourse to the various systems of steam plows, the many advantages of which have long been universally known. We say large cultivators, because, while recognizing the excellence of the mechanical process brought into play by his rich neighbor, the plowman of small or moderate means hesitated about spending the amount of money necessary to purchase steam plowing apparatus and to keep it in repair. At present, therefore, although the steam plow is in common use in farming on a large scale, it is almost entirely excluded from exploitations whose importance is not of the first order.

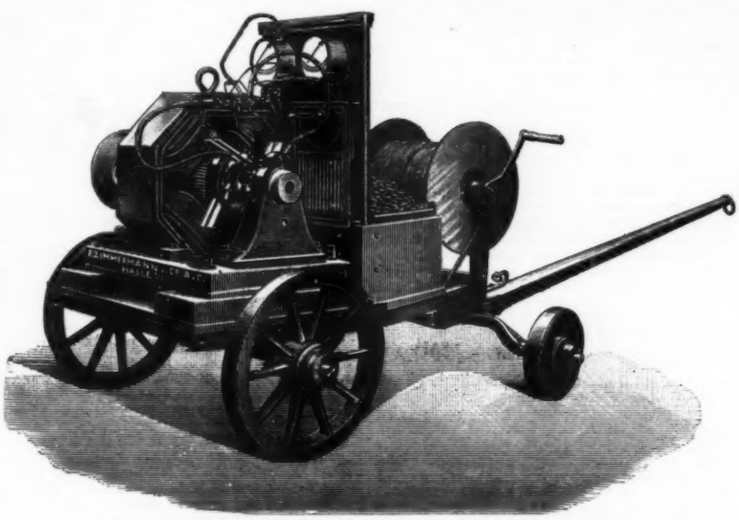


FIG. 1.—A GENERATING DYNAMO MOUNTED UPON A CARRIAGE FOR ELECTRIC PLOWING.

But where steam has not been able to succeed completely, electricity might well prove an economical solution of the problem of plowing. The first trials of the application of electricity in this direction are due to M. Felix, of Sermaize, who a few years ago conceived the idea of substituting a dynamo for a locomotive steam engine for plowing purposes. In this system the expenses were too high, and it is only quite recently that the Messrs. Zimmermann, of Halle, have devised an arrangement that permits of a much more economical use of electric power. They produce electricity by means of a locomotive apparatus that may be placed upon a road or at any point whatever of a field, and carry the energy through cables to a receiving dynamo that forms part of the plow and produces the displacement of the latter. Let us say at once that in farming on a large scale in which steam engines of high power are used, and in sugar works, distilleries and other agricultural works dependent upon the direct exploitation of the soil, it is advantageous to make use of these for actuating the dynamo. Setting aside these large installations in which there exist powerful stationary engines, and also those in which are found waterfalls capable of yielding the necessary power in the vicinity of the fields to be plowed, we are going to see in what consists the arrangement normally necessary for electric plowing. As we have already said, if the generating source of the current changes, it is merely necessary to modify the wiring that conducts the energy, and the principle of the method is not altered.

An endeavor has been made, in the first place, to make the apparatus light, so that the farm animals can haul them without difficulty to the points where they are to be employed, and to permit of the use of the agricultural locomotives that are employed for other purposes, so that the capital invested shall not be increased. The following is the arrangement that has been decided upon:

The plow is of the tilting type, and carries a dynamo. Upon the shaft of the latter there is mounted a double gearing that transmits motion to a second shaft, upon which is keyed a wheel, which guides a chain that is stretched over the field to be plowed and is anchored at its two extremities. When the motor is thrown into gear it draws upon the chain and causes the plow to move forward. At the end of the course the plow is tilted and the direction of the current reversed, and the plow returns to the other extremity in unwinding the chain. The anchors that fix the two extremities of the latter are maneuvered by means of a simple lever upon which the action of one man suffices to pull them up.

In small and medium cultures, any 12 or 15 horse power locomotive may be used. The generating dynamo is placed upon a wagon which, in the displacements, is coupled to the locomotive. When a person reaches the place where he wishes to install his source of energy, it suffices to connect the flywheels of the motor and dynamo by a belt. The only condition that the locomotive has to fulfill is that of having a very sensitive regulator, as, in fact, is required in every engine that actuates a dynamo.

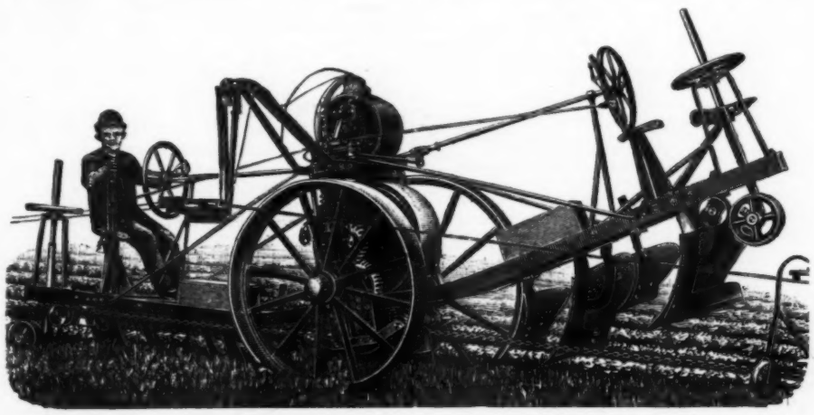


FIG. 2.—THE ELECTRIC PLOW OPERATING IN A FIELD.

The transmission of the electric energy is effected by means of wires corresponding to the two poles of the dynamo and supported by poles through the intermedium of insulators, just exactly as in a telegraph line. The poles are placed along the edge of the field at right angles with the direction that the plow is to follow. In order to take the current from these wires, two trolleys are employed, and these are connected with wires parallel with the travel of the plow. These wires at the two ends are wound around tension carriages and supported here and there by small carriages that participate in the shiftings of the plow. The wires, supported and stretched, as has just been seen, rest upon two special contacts carried by an arm that forms part of the plow. They thus transmit the current to the receiving dynamo through the resistance box. It is this same arm carrying the contacts that lifts the carriages and arranges them at the desired distance apart to effect the return of the plow. The plow is provided with two shares, each preceded by a small colter. It may be completed by scarifiers that stir up the earth to a depth of sixteen inches without turning it over, while the shares plow to a depth of about ten inches. The plow moves forward at the rate of 230 feet a minute.

The installation of the material requires half a day's work; but the time thus employed is soon compensated for by the acceleration obtained in the operation of plowing. Experiments made in Germany have shown that it is possible to plow more than four acres to a depth of ten inches in ten hours. To do the same work in the same time by the old method, it would require four teams of six oxen. The latter walk at a speed of scarcely more than fifty feet a minute.

For heavy soil it would be necessary to construct plows of a somewhat different style, but the installation would be practically the same. The power necessary varies according to the nature of the soil.

In farming on a large scale, in which it is necessary to plow to a greater depth (to fourteen instead of ten inches), and in which it is also necessary to plow from eight to twelve acres per day of ten hours, the installations include, as a general thing, stationary engines and a transmission of energy through coarse wires of polished copper, like those of telegraph lines. The rest is arranged as above stated, with the exception of a few details.

It is estimated that the expense of electric plowing is only about half of that of steam. This is a fine result, and we think that M. Maguin, who is constructing the Zimmermann material in France, will find numerous customers.—La Vie Scientifique.

ADVICE TO BUILDERS OF ELECTRIC RAILWAYS.

By G. WHITEFIELD CHANCE.

As president, manager or superintendent of a railway system, you are interested in motors, brakes, coal bills, salaries of employes, and most of all, earnings. You try to figure down your operating expenses, but, perhaps, like the famous ghost, they will not down. You are looking for leaks. Can you see prospective dividends vanishing before inevitable repairs and renewals?

What do you think of a large city system of electric roads with a nine inch girder rail, under a traffic of 450 car trips per day, after three years' service, crying through motors, cars and riders, for reconstruction. And yet this is only one case out of scores where material was all right but handling all wrong. You are an able financier and manager, but perhaps are handicapped by the lack of foresight of someone.

Roadbed.—In interurban railroad building along country roads, the question of drainage is most important; so also in cities this is an important question, except with good foundation and practically watertight pavement, or where the track is laid on concrete. Often a cheap line of drain tile is as effective as a foot of stone ballast. Especially on comparatively light traffic roads designed to be built cheaply will correct drainage treatment show marked saving. Experience on steam roads has taught us that we dare not obstruct nature, and yet how often is precedent thrown aside? To fully appreciate the value of drain tile one must have lived in or visited "the drain tile States."

Concreting.—There is more money thrown away in bad foundation work than is generally realized. But this special part of your track work is frequently a case of "the devil take the hindermost." If you are laying rails in cities, where excavation is required, no more material should be taken out than is absolutely necessary to get in the foundations. Some work is very loosely done in this respect; a solid bottom should be insisted on in any case. If you are laying where the roadbed can be rolled, it should be done by all means. If heavy traffic is the word, concrete first, last and all the time, and perhaps you may do away with ties entirely, if the conditions are favorable.

Ties.—There are two standard ties in this country, white oak and yellow pine. I have learned, as we all have who have had much to do with the question, that there are ties and ties, and that a competent inspector will save a small fortune to a large company. How many roads in building or even in renewals get what their specifications call for? While there are two standard woods, others may be used in certain localities by using good judgment as to traffic and local conditions, and then comes in the question of the tie plate, its advisability and form, questions again of suiting your appliances to your conditions. A cypress or cedar tie with a tie plate, in certain localities, may be much better and more expedient than a harder wood. A tie plate, even with hardwood ties, is a great saver with heavy traffic or tortuous alignment. Yet again, it may be unnecessary with easy alignment and light traffic. Timber treatment, creosoting and kyanizing are well known methods of increasing the life of the tie and may be used with judgment in certain cases.

Rails.—There has been much written about rails, chemical composition, length, form, etc. For nearly all purposes of track construction, the long rail, preferably the 60 foot rail, has come to stay. The broad, shallow head, high web and moderately wide base give the best results. Where tie plates are to be used, we would naturally use a moderately wide base, but the market forms will have to govern the selection in most cases. The American Society rail or T rail work is good and practical. All the high girders by the principal American mills are good in practice, but the foreign girders are generally of bad head design. Perhaps a rail with greater base width than common would give better results when laid directly on concrete. The chemical composition, heat treatment, and mill inspection are points too little looked after in giving rail contracts. High carbon, low phosphorus and sulphur with a proper heat treatment is the "battle cry" for good rails. It is entirely reasonable to allow a harder, even if more brittle, rail in sheet girder work than in steam work, where a broken rail may mean loss of life and property.

Joints.—These should be good, or none at all; that is, your rail can be practically continuous if you bury

it in rigid paving. We are not yet to the point of laying continuous rail in open track, although recent experiments with cast joint continuous rail seem to point that way. By laying so as to make the stress generally one of tension, with perhaps a slight compressive one at times, and using proper anchorages at curves, we may attain to a continuous rail in open track. But when you must have a joint, let it be the best. If you are using a low rail, use a heavier joint plate in proportion than with a high rail. I would much prefer a joint plate of the type that drops below the base for a T rail, or a combined tie and joint plate. The mistake is nearly general in using a small joint plate with a small rail, with the consequence of a bad track, surface bent rails and general inefficiency. The poor fish splice used with light rails has done more to condemn the rail than the rail itself. My own experience and that of many experts has demonstrated the fact that light rails wear proportionately better than those of heavier section. This is explained by the fact that the head of a light rail gets more work done on it by the rolls and is of a denser construction. In the matter of continuous rails the cast joint is cheaper than the electric weld, by something less than half, a nine inch cast weld joint costing about $3.50, while an electric weld of the same rail costs about $5 per joint.

Bonding.—Whatever style it be, copper, plastic alloy, electric or brazing weld, let it be well done, to which end thorough inspection is necessary, for as with all track work, we usually say good-bye to this part of the system when the "fillers-in" come along. With the cast joint there is a difference of opinion as to the necessity for bonding, some bonding their joints and others maintaining this unnecessary. However, if the right means are at hand, the cast joint can probably be made electrically sound.

Special Work.—Having been engaged in the manufacture of special work for some time, I may here add a word or two of interest and value. We have frogs and crossings now with hard centers—manganese, Harveyized and case-hardened. They are all good and fastened about the same in the first two cases. We have also solid cast steel pieces which are well made. While certain pieces of one manufacture will outwear those of another manufacture in a certain locality, the difference on the average is slight, and great difference of wear can generally be traced to non-uniformity of product. On this account, a guarantee from the maker is in order. The trouble with this class of work is that it is more or less going through the experimental stage. Where you have curves of very sharp radius with heavy traffic, a special steel should be considered. Manganese is the best yet found. Your curves should of course have easements, and the outer rail should be elevated if possible. All curve rails, whether T or girder, of less than 500 feet radius, should be bent at the mill, and if of heavy section, up to 750 feet radius. Switches and mates are also made with special steels in tongues and central wearing parts. These are the best, but for light traffic the less expensive styles will do; however, all depends on how light the traffic is.

Bridges and Culverts.—The number of bridge accidents on suburban trolley lines has been too great. Don't take any risk; you cannot afford to, even if you are operating a cheap line, for if you lose a bridge and a few lives culpably, where will dividends for years go to? Better err on the side of safety, if you must err, but with competent supervision and careful inspection there should be no erring and indeed no unreasonable expense. A guarantee or insurance may relieve you of pecuniary responsibility, but for the good name of your road you cannot afford to have accidents. "Sufficiency" is the word. Don't try to make water run up hill. Give it room.

Overhead Line Work and Conduits.—Your pole line, frogs, conduits, etc., should be good construction and standard practice. There are so many electrical nostrums in the way of overhead fixtures that it takes some care to select the best for the money expended. Poles should be set in concrete. Compressed mica insulators are the best. Creosoted wooden ducts for cables are standard. When the third rail system can be used, it is best and cheapest.

Motive Power.—You may be pleased and edified to note the progress made in compressed air, gas, steam, and other motors, but experience teaches, and it has not yet demonstrated these motors to be superior for urban and ordinary suburban service. The accumulator car, and compressed air motors, are worthy of study, and in certain situations these motive powers may yet find a field.

Power Stations.—The subject of location is both a mathematical and ordinary financial one, and should be left largely to the engineer. For a first-class plant of large units compound condensing engines, water tube boilers, automatic stokers, economizers and direct connected generators are the essentials of economical operation. For a small plant, high speed automatic engines, with belted generators, give good results, while the automatic stoker and economizer may be dispensed with. The subject of pure water supply, purifiers, heaters, pumps, separators and condensers are details that must be worked out in each case.

Cars.—For urban service the single truck car is best, for fast interurban service the double truck car has many advantages. The simpler the truck the better, provided the principle is all right. For fast service something more than the hand brake should be used. The air brake and electric disk brake are both available. The latter has been brought to a state of perfection that will probably meet all requirements, and it possesses the advantage of a direct method of application of power.

Operation.—There is entirely too much looseness in methods of operation of electric interurban roads. For single track lines, either a dispatcher system with orders should be used or an electric train staff system or automatic block. With double track lines an automatic electric block system will meet all requirements.—Western Electrician.

Steiger (Corres. Bl. f. Schw. Aerzte, May 15, 1897) found that of about twenty thousand eyes of children in the primary classes in the schools of Zurich, 1570 were more or less defective. About one-half of these, or 777, were astigmatic. In some of these the affection was light, but in 662 it was described as considerable, while in 318 it was marked.

NUTRITIVE VALUE OF FOOD.

IN order to ascertain the customs and methods of persons of different stations in life regarding the purchase and use of their food, a series of investigations are being conducted by the Department of Agriculture. These inquiries are of a distinctly practical character, and they are made with the co-operation of a number of experiment stations, colleges, and other organizations, as well as of private individuals, in different parts of the country. The general scope of the investigations includes the determination of the amounts and nutritive value of the food consumed by a given number of persons during a certain number of days, and the deducting of the quantities per man per day.

It is believed that such information, coupled with that derived from the study of the composition, digestibility, and nutritive value of food materials in common use on the one hand, and with that which comes from research into the laws of nutrition on the other hand, will gradually make it possible to judge what are the more common dietary errors and how improvements may be made to the advantage of health, purse and home life. A variety of digestion experiments have already been made, and others are in progress under governmental supervision. Accounts of studies of dietaries of families, boarding houses and clubs are from time to time made the subject of official reports.

HOW EXPERIMENTS ARE MADE.

In these studies account is taken of the amounts, composition, and cost of all food materials of nutritive value in the house at the beginning, purchased during and remaining at the end of each experiment, and of all the kitchen and table wastes. Such accessories as baking powder, essences, salt, condiments, tea, coffee, etc., although of interest from a pecuniary standpoint, are of no practical value as regards nutriment. The sum of the different food materials on hand at the beginning and those received during the experiment is taken, and from this sum the quantities remaining at the end are subtracted, thus giving the amount of each material actually used. From the amount thus obtained and the composition of each material, as shown by analysis, the amounts of the nutritive ingredients are estimated. From these are subtracted the amounts of nutrients in the waste, and thus the amounts of nutrients actually eaten are learned. In all of these experimental inquiries account is kept of the meals taken by the different members of the family and by visitors. The number of meals for one man, to which the total number of actual meals taken is equivalent, is estimated upon the basis of the potential energy. These energy equivalents are somewhat arbitrary, and it is acknowledged that they will require revision in the light of accumulating information.

Following is a table of estimated relative quantities of potential energy in nutrients required by persons of different classes:

Man at moderate work	1·0
Woman at moderate work	0·8
Boy between 14 and 16, inclusive	0·8
Girl between 14 and 16, inclusive	0·7
Child between 10 and 13, inclusive	0·6
Child between 6 and 9, inclusive	0·5
Child between 2 and 5, inclusive	0·4
Child under 2	0·3

WHERE STUDIES HAVE BEEN MADE.

The dietary studies already made include a boarding house, a blacksmith's family, a jeweler's family, a chemist's family, an infant nine months old, a college students' eating club, a Swedish laborer's family, a female college students' club, farmer's family, a camping party in Maine, a poor widow's family, a man in the Adirondacks under treatment for consumption, and a mason's family.

As a general thing, the figures used for the percentages of nutrients in each food material are taken from the averages given for like food materials in Bulletin No. 28 of the Office of Experiment Stations of the Department of Agriculture.

The figures in that bulletin represent the results of a compilation of analyses made previous to January 1, 1895. In estimating the fuel values of the nutritive ingredients, the proteine and carbohydrates are assumed to contain 4·1 and the fats 9·3 calories of potential energy per gramme. These correspond to 1,860 calories for one pound of proteine, or carbohydrates, and 4,220 calories for one pound of fats.

FUEL VALUES OF BACON, TURKEY AND COD.

Bacon has a very large percentage of fuel value. The latest official analysis shows that a portion of bacon, with the inedible parts discarded, contains 17·8 parts water, 9·8 parts proteine, 68 parts fat, and 4·4 parts ash, and has a fuel value of 3,050 calories per pound. By the same analysis, the edible portion of a turkey is found to contain 55·5 parts water, 26 parts proteine, 22·9 parts fat, and 1 part ash, with a fuel value of 1,350 calories per pound. Codfish, edible portion, contains 82·6 parts water, 15 8 parts proteine, 0·4 part fat, and 1·2 parts ash, and has a fuel value of 310 calories per pound.

In each of the dietary studies reported the data regarding the kinds and amounts of food material, the persons by whom they were eaten, and the number of days and meals were sent to the Government Experiment Station at Middletown, Conn., where the necessary computations were made. For the sake of simplicity and convenience, the computed quantities for one man for ten days are given, instead of the actual quantities consumed, or the quantities for one man for one day. If the quantities were stated as actually consumed in the period of each dietary, it would not be easy to compare the quantities in different dietaries. By putting the quantities for all of the dietaries on one basis, however, the relative amounts of the different kinds of food materials, as meats, milk, bread and the like, in the different dietaries are readily compared. If the quantities were given per man per day, some would be too small for printing without the use of an inconvenient number of decimal places.

WHAT A LABORER'S FAMILY ATE.

A fourteen days' study was given to the dietary of a laborer's family in Hartford, Conn. The family consisted of man and wife, three girls, aged respectively four, six, and eleven years; a boy, two and a half years old, and an infant. The father was a laborer in a coal yard, earning $8 per week. The mother had worked as a servant before her marriage and did her own cooking. The food materials bought by this family consisted of beef, veal, mutton, pork, salt codfish, eggs, butter, milk, rice, flour, rolled oats, bread, beans, sugar, potatoes, onions and raisins. The consumption of food, calculated for one man ten days, was: 13·2 pounds of animal food, 9·6 pounds of cereals and sugars, 11·1 pounds of vegetables, and 2 pounds of fruit—a total of 34·1 pounds. This total quantity cost $1.63, and it contained 2·41 pounds of proteine, 2·24 pounds of fat, and 9·59 pounds of carbohydrates, the aggregate fuel value being 31,760 calories per pound. The following table shows the nutrients and potential energy in the food purchased, rejected, and eaten by this entire family during the period of fourteen days:

FOR FAMILY, 14 DAYS—FOOD PURCHASED.

Food materials.	Cost.	Nutrients. Proteine. Grms.	Fat. Grms.	Carbohydrates. Grms.	Fuel Value. Calories.
Animal	$5 62	3,312	5,239	1,076	66,710
Vegetable	3 51	2,816	444	23,519	112,100
Total	$9 13	6,128	5,683	24,595	178,810
*Total	..	38	99	98	1,480
†Total	9 13	6,090	5,584	24,497	177,330

* Waste.
† Food actually eaten.

PER MAN PER DAY—FOOD PURCHASED.

Animal	$0 10	59	94	15	1,175
Vegetable	0 06	50	8	420	2,000
Total	0 16	109	102	435	3,175
*Total	..	1	2	2	30
†Total	0 16	108	100	433	3,165

* Waste.
† Food actually eaten.

WHAT A CAMPING PARTY REQUIRED.

In the summer of 1895, four young men, from nineteen to twenty-two years of age, spent some time in canoeing and camping on the Allagash River, in Maine. As they took their journey leisurely, they may be considered as being engaged in light work. The whole time included in the dietary study of this party is estimated as equivalent to 115 days for one man. The following table shows the nutrients and potential energy in the food purchased, rejected and eaten by this camping party:

FOOD MATERIALS.

Food materials for party.	Nutrients. Proteine. Grms.	Fat. Grms.	Carbohydrates. Grms.	Fuel Value. Calories.
Food purchased:				
Animal	12,169	27,396	2,331	314,230
Vegetable	7,616	2,625	59,018	297,610
Total	19,785	30,021	61,349	611,840

PER MAN PER DAY.

Food purchased:				
Animal	106	238	20	2,730
Vegetable	66	23	513	2,590
Total	172	261	533	5,320

The average of thirty-eight dietaries recorded by the government officials makes the following interesting showing:

DIETARIES.

Dietaries.	Nutrients. Proteine. Grms.	Fat. Grms.	Carbohydrates. Grms.	Fuel Value. Calories.
Food purchased	111	140	447	3,595
Food waste	7	11	13	185
Food eaten	104	129	434	3,410
Estimated digestible nutrients in food eaten	96	124	423	3,285

CHARACTER OF SANDOW'S FOOD.

About a year ago, during an engagement of Eugene Sandow, the "strong man," in Washington, an attempt was made to determine the character and amount of the food he consumed. Mr. Sandow claims to be the strongest man in the world, and at the time of the investigation he had the appearance of being in perfect health. He did not then follow any prescribed diet, but ate whatever he desired, always being careful, as is his custom, to eat less than he craved. He always ate very slowly. He smoked a great deal, and drank beer and other beverages. Below is the result of a study of Sandow's dietary for one day:

Food consumed. (Quantities in ounces.)	Nutrients. Proteine.	Fat.	Carbohydrates.	Potential energy.
Dinner January 10.	Lb.	Lb.	Lb.	Cal.
2 oysters, 10 soup, 1 celery, 3 fish, 1 potatoes, 2 oyster plant, 1 green pease, 1 tomatoes, 2 bread, 2 roast beef, 2½ chicken, 4 ice cream, 3 orange sherbet, ½ cakes, 1 butter, 11 wine (Burgundy)	0·17	0·14	0·34	..
Supper.				
8 roast beef, 7¼ rye bread, 3½ Camembert cheese, 2 water biscuit, 3½ cakes, 4·4 lb. beer.	0·26	0·14	0·61	..
Breakfast, January 11.				
9 vegetable soup, 2 potatoes, 3 veal (breaded chop), ½ green pease, 2 roast beef, 4½ bread pudding, ½ cakes, 14 beer	0 14	0 05	0 16	..
Total in pounds	0·54	0·33	1·11	4402
Total in grammes	244	151	502	..

It was noted that Sandow rejected all of the visible fat of the meat served him, and in his case it was shown that while the amount of carbohydrates and fat consumed did not differ very greatly from the standard

for a man at muscular work, the amount of proteine (albumen) was very large. The fact that so much proteine was consumed by Sandow sustains the theory advanced by scientific experimenters that the energy which is used in the production of severe muscular labor is furnished by the combustion of proteine.

Official experiments regarding the digestibility of food by healthy men are now in progress. It has been demonstrated that 98 per cent. of the proteine and 97 per cent. of the fat in animal foods is readily digested; also that 85 per cent. of the proteine and 90 per cent. of the fat in cereals and sugars, and 80 per cent. of the proteine and 90 per cent. of the fat in vegetables and fruits is readily digested.

DO WE TAKE TOO MUCH ACID FOOD?

THE affirmative of this question is strongly maintained by Dr. W. T. English, Pittsburg, in a paper read on June 3 before the Section on Physiology and Dietetics of the American Medical Association, at its annual meeting in Philadelphia, and published in the Medical News (July 17), from which we quote the following paragraphs. The writer begins by noting that, instead of confining our use of acid fruits and vegetables to the summer months, as Nature intended, we now eat them all the year round. He says:

"It would be impossible within the scope of this paper to refer to the individual products concerned in the ever-increasing list of acid foods consumed in this country. Left a few suffice. Tomatoes, which depend for their flavor upon a peculiar acid (acidum lycopersicum), have rapidly grown in favor, until, from comparative obscurity, they have reached the head of the list. It has been estimaed that during the years intervening since 1890 this vegetable has multiplied in production ten times.

"Each week during 1885 it required twenty-five carloads of lemons to supply the city of New York. At the present time the daily demand exceeds that amount. This is true of other cities, and for the most part the country demand is proportionately augmented. Oranges are supplied in about the same relatively increased quantity. Limes are the most keenly acid of all fruits. Almost unknown outside the fashionable drinking halls five years ago, to-day they are a commodity. They are imported pickled as well as fresh, and the bottled juice comes to this country in large quantities from the West Indies. Congress has recently placed a special tax upon this fruit, because of its large importation. The grateful acid of the rhubarb leaf, in conjunction with binoxalate of potash, with the malic acid contained in gooseberries, currants, cherries, plums, apples, and pears, adds to the acidulous tide.

"Recently it was learned from a large commission merchant that apples, to be salable in our markets, must be decidedly acid. Sweet apples are employed only in making cider and vinegar. Some varieties of the small sweet fruit have almost disappeared, and their places have been filled by those that are tart enough to please the present acid taste. . . .

"It is claimed that the cheapness of sugar permits the consumption of acid fruits which otherwise would be distasteful. The ingenuity displayed in bringing acid into a condition to make it palatable serves to prove the increasing tenacity of the acid habit. Sweet and neutral vegetables, as beets, cabbage, lettuce, etc., are often rendered acid in order to give to them the much desired sour flavor. Forty thousand tons of cucumbers are raised and eaten within the limits of the United States each year, and this affords an excuse for the employment of about 1,000,000 gallons of vinegar and acid sauces or condiments. The large pickle factories that began with the decade have been reinforced by new establishments and additions that double their capacity for sending out acid products. The demand for piquant sauces has caused a large special industry to arise within the twelve years now ending. Meanwhile the home culinary department has augmented its capacity as to quantity and variety. A considerable amount of salicylic and boracic acids contributes to the preservation of fruits. . . .

"The realm of acid ingesta geometrically expands when we enter the domain of drinks. In the drinking halls the casual observers cannot fail to be impressed with the tendency to indulge in acid beverages that are of recent origin, while those of more or less remote popularity still occupy their position as to quantity consumed. But if the question were asked to-day as to what is the national drink, it would be answered by the fizz of the soda fountain. . . . Foreign countries know little about the American soda fountain, but it increases the acid consumption one hundredfold in this country. The most profitable and largest part of the druggist's trade to-day is that of the product of the soda fountain. Mineral and vegetable sours contribute to the tide of acids which enter the stomach from this source. . . . Small lunches are supplied at some soda counters, consisting of hot tomato and clam bouillons, beef tea, cocoa, chocolate, coffee, tea, ice cream soda, cake, crackers, etc. The most common demand, however, is for the acid-flavored drinks, including mineral and vegetable acids, with water charged with carbonic acid gas. . . .

"All this obtains, too, in spite of the fact that acids are naturally rejected in early childhood, and only rendered tolerable or agreeable by acquired appetite. The increased consumption of acid foods and drinks cannot be accounted for by the increased population, for it is out of all proportion to its growth. Indeed, our population during the last decade has remained almost stationary, while the acid demand is increasing in geometric ratio each year. The consumption of acid foods has increased out of proportion to all other foods, and the amount of acid drinks ingested has doubled every year since 1890.

"This extending and increasing appetite for acid foods and drinks is evidenced by the self-conscious need that many feel for antacids to counteract acidity of the stomach. Wherever sour drinks are sold there are also the antacid, as bicarbonate of soda, magnesia, etc., on hand for the accommodation of those who cannot uninterruptedly continue the acid pace. Again, medical men will admit that the trend of therapeutics is forced, however unconsciously, into the antacid and antifermentative realm. This is not only because of the introduction of sour acids, but is also due to the fact that the acid conditions favor the development of micro-organisms and promote fermentative conditions in the body. These micro-organisms are always more injurious in their effects than the acids that are used as foods and drinks.

"The various modifications of the digestive function incident to the excessive use of acid foods and drinks are already with us, and the acidulous habits of the body mark a stage in civilization. These facts, stated in connection with the estimates above made, should satisfy all that the acid appetite fostered and gratified is contrary to physiologic law. It may further be argued, however, that the acids employed are not only unfavorable to proper digestion, but that they directly and indirectly modify the chemic composition of the blood and bodily fluids."

We have not space to follow Dr. English as he traces the influence of this excess of acid through all the nutritive processes, when, according to his view, it neutralizes the alkalies in the bile and pancreatic juice, thus rendering them of no effect, and similarly destroys the alkalinity of other bodily fluids, including the blood, which to insure immunity against infection should be normally alkaline. We close with his final paragraph, in which he suggests that the effects of an acid diet may be even more far-reaching than this and may include the sphere presided over by the brain. After noting that when the alkalinity of the serum is reduced the red blood corpuscles contract and lose their vitality, he says:

"It must be remembered that the red blood corpuscles are the servants of the respiratory apparatus, and by this interference with their office there must be a reduction of the efficiency of the functions of respiration. The sympathetic nervous system is influenced by hyperacidity, and causes in turn a general functional derangement of the organs, notably the heart. The intellect is temporarily confused, and in some this confusion reaches out into incoherence of thought and action. The moral influence of these perturbed conditions of heart and mind extend to and pervert the imagination, and in extreme cases leave their permanent impress."

SNUFF INEBRIETY.

IT is a well-known fact that a large number of persons use tobacco snuff to excess.

In some sections of the country this addiction is very general, and prominent in the marked degeneration of the victims.

The narcotic effects of tobacco used as snuff seem to cause a profound depression of all the senses, and the body generally. The higher psychical life appears to suffer most, manifest in loss of pride of character and appearance, diminished ambition to excel in any work, disregard of surroundings and opinions of others. Later, delusions of persecution and injury, with suspicion and doubts of anything that is true.

A form of low general dementia follows, terminating in death from melancholy or acute disease.

Recently another form of snuff taking, in which cocaine is the central drug used, has come into prominence. Cocaine is given for some of the distressing catarrhs and nasal troubles which are so painful. Its narcotic action on an inflamed mucous membrane is very marked, and is quickly followed by a certain fascination to continue the drug which is difficult to control. The possibility of not being able to give up the drug never occurs until symptoms of obvious poisoning appear, and then, in many cases, the mind has lost all power of appreciating its real condition. Voluntary efforts are usually confined to changing to some other narcotic used by the mouth. The effects of cocaine by the nose, in most cases, differ but little from its use in other ways. Yet there is a certain mental fascination in the inhalation, as in the use of the needle, which is hard to overcome. The delirium and pleasing relief, with mild excitement which follows, make this form of inebriety most attractive.

The rapid exaltations of the sense of comfort and strength, and sudden disappearance of pain and mental fears and worriment, all make a powerful impress on the mind and nerve centers. This for a long time is far more powerful than the depression and suffering which follows.

There can be no question that this form of inebriety exists to a considerable extent in all our large towns and cities. A very sensational story of a large number of persons in a certain Eastern village affected in this way has some foundation in fact. It appears that a certain druggist pushed the sale of a nostrum containing cocaine used in this way, until the demand was very large. The appearance of the toxic effects of cocaine in several persons resulted in an exposure of the danger of the drug, and its sale practically ended. No doubt similar instances are occurring in individual cases where the drug is not abandoned, and cocaine inebriety or other drug taking follows. As a nasal remedy it is exceedingly dangerous, and should be concealed and guarded by the physician with great care. The use by inhalation is more likely to become an addiction than by the mouth or needle. The treatment is surrounded with great difficulties, and often taxes all the resources of the physician to the utmost.—Quarterly Journal of Inebriety.

GERMANY'S INDUSTRIAL GROWTH.

THE following encomium on Germany's recent industrial awakening, especially as applied to the textile manufactures, appears in Kuhlow's German Trade Review:

In the year 1879 industrial Germany may be said to have emerged from infancy into youth. From that year on factory chimneys began to jostle and crowd mediæval castle towers. The brick walls of modern factories began to shut from view venerable piles of masonry whose ages were reckoned by centuries. From that year fair Saxony, on the east, began to throw off her humdrum quiet and assume a textile leadership, while on the west the beauties of the Rhine were gradually clouded by the smoke from factory chimneys. Then, too, began the transition of agricultural into urban populations. Quiet, lethargic market places, whose peace and repose had long been a proud heritage, began to resound with the clatter and tread of hurrying throngs; the hum of machinery began to be heard where before no sounds had greeted the ear but those which accompany the easy movements of a contented rural people.

Textile industries had been going on there for centuries, but they were not the industries of to-day; they were industries which did not call for the aggregation of humanity at any one spot, because they depended on individual rather than mechanical effort.

During several decades preceding 1879 Germany's textile industries had scarcely progressed. They had been locally important, but stationary. She did not even supply the demand of her own markets. While the English free traders were, perhaps, not quite unselfishly, preaching their theories, England was marching forward rapidly, because she had extensive foreign markets scarcely open to any other country. Germany was eager to emulate success and was easily infected. She tried free trade for eight or nine years, only to find herself more dependent on England than ever. During that period it was common to read signs in the store windows of German cities bearing the legend, "English goods sold here," though, perhaps, not so common as it is to-day in England to meet the phrase, "Made in Germany." It seems almost incredible that a little over twenty-five years ago the production of cotton fabrics in France exceeded that of Germany, and that only by the acquisition of Alsace and her 2,000,000 spindles was Germany able to take precedence of France in the tabulated statistics of the manufacture of textiles.

Before Germany had thoroughly experimented with free trade, the United States, under protection, had performed marvels in debt paying and had practically accomplished material prosperity. This was an example for the world to copy. In 1879 the Germans determined to cast aside the free trade theories and try protection, and from that year Germany has been an industrial factor to be reckoned with. From a weak and insignificant square on the chessboard of the world, she has moved to an absolutely commanding position.

But while, without a doubt, protection was the moving cause of this industrial revolution, it was not the only cause. Protection to her industries would alone have accomplished little of what has been done in Germany since 1879. To the thoroughness of her methods quite as much as to protection must the change be attributed. German methods were as thorough between 1870 and 1879 as they were immediately after, yet she did not advance industrially in that time. She did not lose, except in competition with England, but she did not advance in comparison with other countries. From the moment her industries were protected Germany's industrial future was assured. She leaped and bounded forward with giant strides, which at first made men wonder and now make nations marvel and admire.

Having so well prospered under protection, Germany turned her attention to extending her markets, since she was able to hold her own at home. She profited by the lesson taught by the United States—that of reciprocity with other nations whose commodities she could take without injuring her own industries. Local sacrifices, of course, were inevitable, but they were as nothing balanced against the gains to the country's trade as a whole. During the two years or so since the conclusion of her treaty of reciprocity with Russia, Germany's textile industries have increased phenomenally. The trade of Saxony, of Crefeld and Elberfeld, and of Eastern Prussia, are notable examples. The textiles from these localities now find their way all over the land of the Czar, where before they were practically unknown.

Of Germany's commercial and industrial methods too much cannot be said in commendation. They are typical of the German character—thorough, enlightened, and the result of close observation and application. There may be some ports her textiles do not reach, but they do not compare in number with the ports where her manufactures have superseded those of other countries. In every country where German textiles are sold they will be found to be as closely adapted to local requirements as is possible, and to be marketed according to local requirements.

Since 1879—as hundreds of our own, as well as English, consular reports are constantly stating—German merchants have thoroughly familiarized themselves with the needs of all the peoples of the world who were willing to purchase German merchandise. They have not accomplished this by sitting in their mills or offices and studying consular reports.

It is considered an essential part of a German manufacturer's commercial education that he speaks several languages, and that he shall have spent some considerable time in travel or residence abroad, where business is being done or may be done.

German manufacturers establish wholesale dry goods houses in all important foreign markets, and are represented therein by agents who speak the language and are familiar with local methods and requirements. In fact, from the moment a German manufacturer of textiles determines to push his products in any particular foreign market, he does it very much as though the goods were made there and everything connected with the business was domestic instead of imported. This, combined with a rigid honesty, true representations, and the expectation of only a reasonable profit, has been the method under which German textiles have gained a strong hold all over the world, where two decades ago they were, if not unheard of, at least unknown.

In the past twelve or thirteen years Germany's trade with some foreign countries has increased tenfold; with most it has more than doubled. And this despite the fact that throughout the textile industry wages have been steadily increasing. Skilled labor in Germany often commands a higher wage than in England, while the labor as a whole is nearly as well paid as in England, and certainly much better paid than it was under free trade in Germany, when the industry was not even supplying the home market. Wages have increased, and hours of labor have decreased.

The thoroughness of the German method begins at the beginning—with the mechanic and the laborer. Without efficient labor to carry out the designs of those who plan, enterprise would exert itself in vain. In the German textile industries the most skilled labor is in most constant demand.

It has been pointed out by Lord Rosebery to Englishmen, and by several advanced thinkers in the United States to Americans, that one of the causes of Germany's success in industrial warfare is the superiority of her system of technical education. Her technical

schools will be found in and about every industrial center, and wherever they are found it will be admitted that they have so largely increased the efficiency of the workpeople that equal results could not have been obtained without them.

The technical schools are liberally supported by the state, and they provide the means for all who wish to become expert workmen, instruction being given by day and by night.

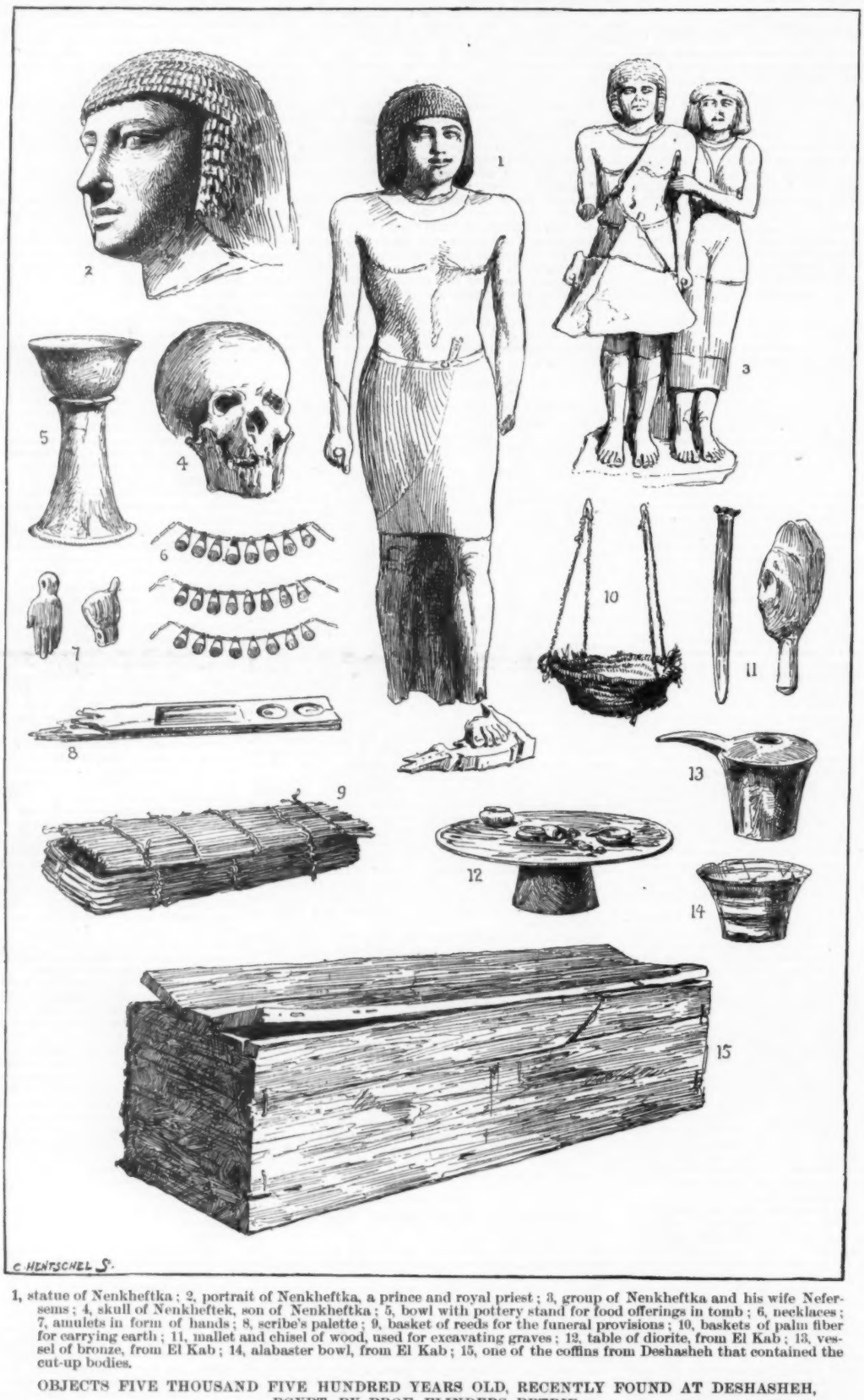
But the value of the German method lies as much in her commercial as in her industrial thoroughness. The business is an inheritance from father to son, each in turn endeavoring first to maintain and then to improve the legacy. Johann Esche introduced hosiery knitting into Saxony some two hundred years ago, and that business has descended from father to son to the present day without a break. In another instance there have been only four changes in the personnel of a firm in just one hundred years. The sons of manufacturers are thoroughly trained for their future calling before taking any active part in business. In Saxony, to mention only one center, there are only forty commercial schools where the future merchants are prepared for their successful careers at home and abroad. In these commercial academies the instruction is practical and thorough.

Stock companies are comparatively few. The payment of interest on watered stock and inflated capital is an unknown evil in the German textile industries. Most of the factories are owned by families or small corporations. Enormous profits are not expected, management is frugal, and there is less ostentatious display of wealth, and therefore little greed for the means of making it.

A steel bridge, cantilever, 140 feet in span, to connect the Rue Stephenson, in Paris, with the Rue de la Chapelle, will be put in place over the tracks of the Nord Railroad in a single night without using supports or interfering with the trains.

CANNIBALISM IN ANCIENT EGYPT.

PROF. FLINDERS PETRIE is now exhibiting the r sult of the explorations he made last winter at a sp called Deshasheh, on the Nile, about fifty miles sou of Cairo. He was fortunate enough to come upon group of tombs which date as far back as the fift dynasty, about 3500 B. C. In these he found ma coffins with bones in them, but no mummies; an earli form of burial had been in existence, in which th bodies were cut up, the flesh entirely removed, th bones carefully wrapped up in cloth, and placed in th coffins. The professor comes to the conclusion, based upon statements by Herodotus, Strabo, and other authorities, that the flesh had been cooked and eaten as a sacred rite in connection with the dead. With the Massagetae, when a man reached an old age, it was considered to be a happy and honorable death to be sacrificed and eaten; and it was looked upon as a great misfortune to die before being entitled to this distinc-



1, statue of Nenkheftka; 2, portrait of Nenkheftka, a prince and royal priest; 3, group of Nenkheftka and his wife Nefersems; 4, skull of Nenkheftek, son of Nenkheftka; 5, bowl with pottery stand for food offerings in tomb; 6, necklaces; 7, amulets in form of hands; 8, scribe's palette; 9, basket of reeds for the funeral provisions; 10, baskets of palm fiber for carrying earth; 11, mallet and chisel of wood, used for excavating graves; 12, table of diorite, from El Kab; 13, vessel of bronze, from El Kab; 14, alabaster bowl, from El Kab; 15, one of the coffins from Deshasheh that contained the cut-up bodies.

OBJECTS FIVE THOUSAND FIVE HUNDRED YEARS OLD, RECENTLY FOUND AT DESHASHEH, EGYPT, BY PROF. FLINDERS PETRIE.

tion, for those who died of disease were not treated after this fashion. One of the rude coffins that contained a cut-up body is given among the illustrations. All the objects represented, with the exception of three from El Kab, are from Deshasheh, and they possess a great interest from their extreme antiquity. In one of the tombs a very fine statue was found. It represents a prince and royal priest, named Nenkheftka; a portrait or careful drawing of his head is given, to show what a man was like on the banks of the Nile 5,500 years ago. This statue is good evidence that sculpture was far from being a primitive art at that early date. There is also a group of the same man and his wife, Nefersenu; also the skull of their son, named Nenkheftek. The wooden chisel and mallet, as they would be useless in cutting stone, are supposed to have been employed for excavating the earth in making graves. It may be mentioned that small baskets, like the one shown in the illustration, are still used in India, where women and children carry earth at railway making or other works.—The Illustrated London News.

THE THEATER OF INSECTS.

By JOHN H. LOVELL, in Popular Science News.

THE first zoological book printed in England was "The Theater of Insects," by Moufet in 1634. The title of the book would suggest that the author, after the manner of old Izaak Walton, was wont to moralize a bit over his studies of natural history. We fancy that he saw, as upon the stage, both tragedy and comedy in the lives and ways of the little known insect world. "The Theater of Insects" differs from all other theaters in that its busy season comes during the summer months. Just as, in the long ago, historical geology tells us that flowers and insects appeared in the world at the same period of time, so now in the early spring the blooming of the first flowers announces the awakening of insect life. If during the last week of the month of May you visit a cold, damp woodland of Northern New England, your attention will at once be arrested by the handsome and conspicuous blossoms of the hobble bush or wayfaring tree. The large flower buds are formed the previous season, pass the winter wholly naked and open in spring with the appearance of the leaves. This shrub may be easily recognized by its straggling habit of growth, its drooping branches, and the broad flat heads, or corymbs, of flowers of two different sizes. The center florets are small, greenish in color, and in autumn produce bright red berries; while the marginal ones, a single row of which surrounds the corymb, are large, white, and sterile. Their size has been increased at the expense of their power of producing seed, and as their use is to attract the attention of insects, they usually open some days in advance of the inner and smaller florets. But for them, the blossom would easily pass unnoticed amid the budding foliage, as may be easily proved by cutting them off. Since their conspicuousness is useless to themselves, but of benefit to the community, they may be said to unconsciously play the part of benefactors.

A sort of barter or exchange is carried on between the flowers of the hobble bush and the insects, by which each is of service to the other. A small quantity of honey, in a thin layer, is secreted by the inner florets, and as insects pass quickly from floret to floret in search of this, their bodies become covered with pollen, and they repay the plant for the food they obtain by effecting cross fertilization. Let us carefully watch the flower on a sunny day and observe how successful it is in attracting insect visitors. I have taken upon it and have now in my collection three species of bees, one butterfly, a small brown species of miller, three hemiptera, five flies, and seven beetles, or twenty species in all, a large number for the month of May. Butterflies are rarely met with, for as the honey is fully exposed and not concealed in a deep pit, as in the pinks, the flowers are adapted only to the visits of short lipped insects such as flies and beetles. Upon the open flowers they can readily obtain both honey and pollen, and in consequence are the most frequent visitors.

In gathering honey from the flowers of the hobble bush there would seem to be no possible danger to insects, and yet they not infrequently meet with a tragic end. Here lying upon the flat top of the blossom is a dead fly. Lift it up and you will discover how it was killed. The head is firmly grasped by the mandibles of a white spider, which, rather than release its prey, permits itself to be dragged from its hiding place and deposited in your collecting box. Except for a red lateral stripe on the abdomen, its color closely resembles that of the flowers amid which it lives, and of whose power of attracting insects it has learned to make use for its own benefit. I have never been able to observe this spider in the act of seizing insects, but I believe it catches them while they are sucking honey. A member of this same family of spiders also frequents the pyramidal flower clusters of the hardhack, and I have known of its capturing so large and strong an insect as the hive bee.

In a previous article I referred to the habit of bees of puncturing the spur of the yellow jewel weed (Impatiens fulva), to obtain the honey more easily than by entering the saclike flower in the legitimate way. In like manner bees puncture the two lipped tubular flowers of the common skullcap (Scutellaria galericulata). In two instances a narrow slit was observed on the upper side of the curved corolla tube, and in a third case the whole upper portion of the tube was cut away, leaving the lips suspended by a mere thread. The buds while still quite immature are also punctured at the apex, usually on the under side. The piercing of nearly mature buds has been recorded of Lamium album, but never before, so far as known to the writer, of the skullcap. The perforation of the flowers of the Labiatæ by bees is, however, of common occurrence. Both the maxillæ and mandibles appear to be employed, the former for piercing and the latter for biting away the tissue, and both the bumble and hive bees are known to make use of the holes in extracting honey. If, after the manner of certain plants famous in myth and story, the Impatiens (fitly, in this respect, named touch-me-not) could speak, what a protest it would utter! For unknown centuries it had been developing the color and form of its flowers, only at last to find its work in danger of being rendered worse than useless by a change in the habits of its bee visitors. It should, however, be mentioned that the flowers in North America are visited by humming birds, and I have also seen another smaller species of bee enter the flower in search of pollen.

THE IGUANAS IN THE ZOO AT LEIPZIG.

OF the many wonders which the Zoological Gardens of Leipzig offer to the gaze of visitors, a pair of fine iguanas form a principal feature, attracting at once the attention of scientists and laymen alike. We reproduce a cut from Illustrirte Zeitung, which their artist drew from life, and which gives a very good idea of the external appearance of the giant lizard—for of the family of the saurians, the iguana is a member.

In technical language, the animal is called Iguana tuberculata, the first part of the name being derived from the language of the natives of Hayti, where iguanas are found; the second, of Latin origin, referring to the excrescences on the head and neck (tuber, a boil, from tumeo).

The head is large and square, the neck is short and strong, the body is long and flattened out sideways, and ends in the long tail, which is covered with sharp scales. All over the body, along the spine, a sharp pointed comb runs from the back of the head to the tip of the tail, giving the beast a dragon-like appearance. This is rendered yet more striking by the baggy skinfolds at the throat, which also are set with thorny scales. The whole body is thoroughly protected against the attacks of such enemies as the iguana is likely to meet.

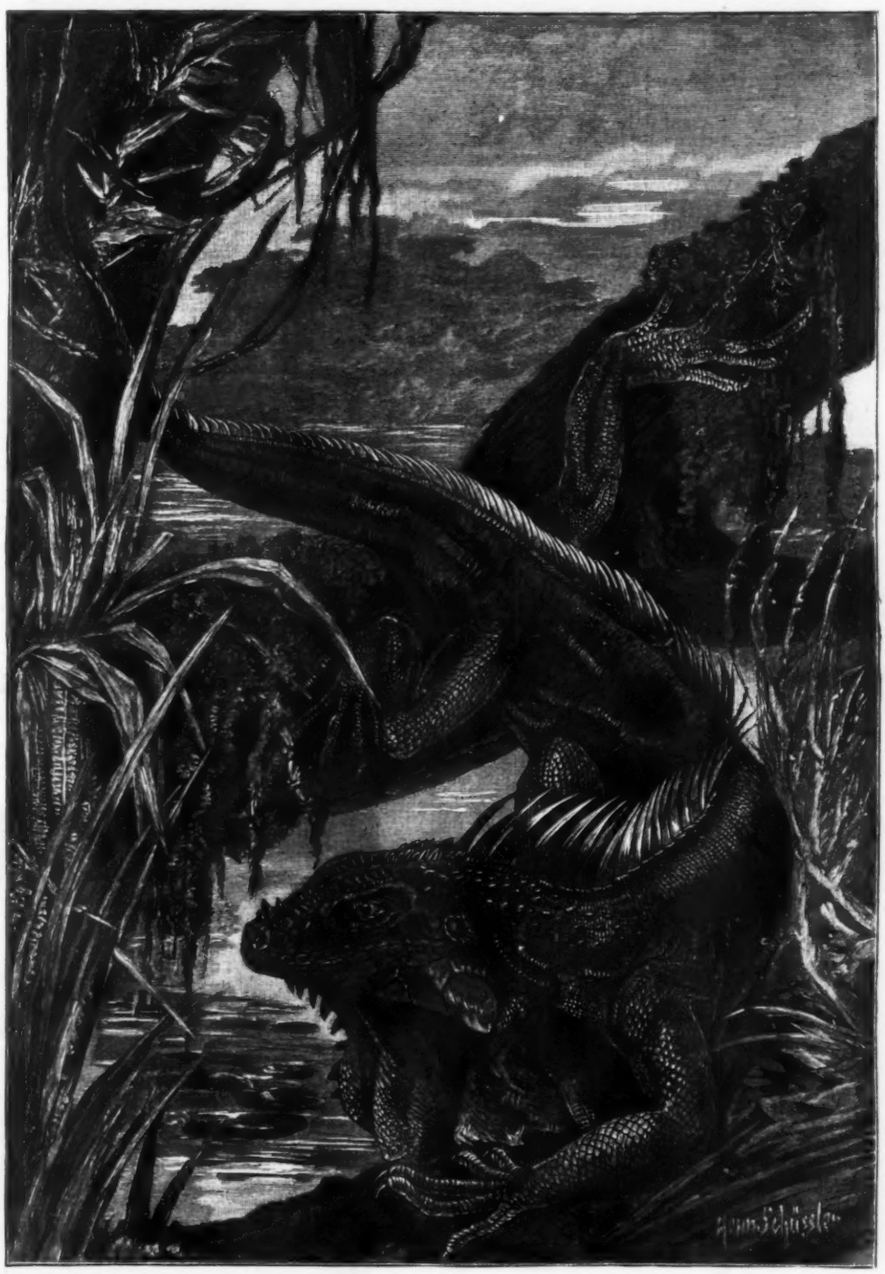
The head is incased in scales which are partly flat, partly convex, lumpy or ridged. The rest of the body has feebly ridged scales. The ears are large and freely attached to the head. The animal often attains a length of 5 feet, over 3 feet of this total being taken up by the tail. This tail is by no means a useless ballast, but is used both as a means of propulsion and for steering when the iguana takes to water, where it is quite as much at home as in the forest. Here, in climbing, in leaping after food from branch to branch and from tree to tree, it avails itself of its strong feet, with their long, sharp claws, and by them becomes a truly dreadful foe to the small birds and lizards of which it occasionally makes a repast.

Examination of the stomach of these animals has shown that, as a rule, they live on vegetable food. Still, there were found among the contents of the stomach, besides remains of small birds and lizards (which we mentioned above), eggshells and small animals of various description.

The iguanas are vicious, wily, but show staunch resistance when attacked. In defense they use their pointed, back-curved teeth, and slash with their tails, blows from which are rendered dangerous by the sharp comb.

The male iguana choses a partner once, and does not quit her after. He will protect her against any other animal, and fiercely assert his privilege in having secured her favor.

The females lay their eggs on sand banks, carefully bury them in the sand, and pay no further attention to them. The heat of the sun, in time, calls the young iguanas from the soft-shelled eggs.



THE IGUANA IN THE ZOO AT LEIPZIG.

To hunt these lizards a gun is useless as a rule, for they can stand a heavy charge of shot, and once warned are soon safe, either in water or dense foliage. A more certain means of laying them low is an Indian arrow, which is often deadly. Dogs also are trained to bring to bay this queer prey. Animals secured are brought to market, where they are sold at a good price, to be consumed on the boards of wealthy people.

In captivity iguanas at first prove vicious, and snap at their keepers. They must be kept fairly warm, and the temperature around them must be constant, else the climate soon tells upon, and their life is ended by an untimely death.

To get them accustomed to the feeding, it is usual to worry them till they open their mouths, then the food is brought under their teeth, and, once bitten, is soon devoured. In time the persuasive power of hunger proves stronger than the stupefaction caused by the unaccustomed surroundings, and no further trouble is given in that respect.

THE REPRODUCTION OF THE EEL.

By Henry de Varigny in La Nature.

One of the problems that has occupied the attention of naturalists from the time of Aristotle up to the present is the method of reproduction of the eel. It is not because there has been any reason for the belief that this fish multiplies by processes different from those of other living beings, but because the conditions under which the fertilization of the egg is accomplished and where it is hatched have not been known, and because, too, it has never been possible to obtain the fry of this fish. The problem has now been definitely solved by the researches of Prof. G. B. Grassi, of Rome, and of his pupil Signore Calandruccio. The results may be summed up as follows: The fact that eels introduced by man into ponds and lakes that have no communication with rivers and the sea do not reproduce, and that no young are ever observed therein, has led to the idea that reproduction does not take place in fresh water, and the admission has had to be gradually made that the eel proceeds to the operation of multiplication in salt water. There would be here a migration similar to that made by the salmon and shad, but in inverse order, the latter, inhabitants of salt water, ascending fresh water streams to spawn, and the former, an inhabitant of fresh water, going out to sea to reproduce its kind. This view, à priori, finds some confirmation, moreover, in the fact that the only young eels that are met in rivers are always making the ascent thereof. They ascend, but do not descend streams, and they seem to come from the sea.

The eel therefore appears to reproduce itself in salt water; but where? And how is it that young eels are never found anywhere upon the coasts?

An interesting fact pointed out by Prof. Yves Delage, of the Sorbonne, some eleven years ago, ought to have put investigators upon the track. This fact was that a certain fish captured in the vicinity of Roscoff, and kept in captivity, changed into a conger, or sea eel. This fish belonged to a well-known group, that of the Leptocephala. This group has been a puzzling one, since the fishes that compose it seem to be incomplete, and they have a larval appearance. Their very small head (whence their name), the absence of scales, the slight development of the osseous skeleton, the absence of red corpuscles in the blood, and the general feebleness of their locomotion, all seem to indicate that these fishes, which are divided into several species by systematic zoologists, are young and not adults. In 1861 it was thought that they might be the larvæ of Cepola. In 1864 an American naturalist placed them in the family of eels, but Günther, in 1870, contended against these views in taking as a basis the fact that the Leptocephala are of larger dimensions than the young eels that ascend streams, and he regarded them as monstrous larvæ.

The transformation observed by Yves Delage, however, clearly showed where the truth was to be found, and Messrs. Grassi and Calandruccio resolutely entered the path opened by the French naturalist. Their success has been complete, and they must be congratulated upon it. Through them we now know that the fishes of the family Murenidæ first pass through a larval stage, and that the Leptocephala are nothing but the larvæ of Murenidæ. The Leptocephala therefore disappear, both as regards genera and species. They have no longer any zoological civil state and no longer form a systematic group, any more than do the tadpoles of the Batrachians or the caterpillars of the Lepidoptera; and the fact observed with regard to the common conger eel has likewise been observed with regard to several Murenidæ, and particularly the common eel.

The eel which interests us more particularly goes out to sea to reproduce its species. It does not, however, proceed everywhere to the work of reproduction, but makes a selection from among the innumerable sites that the sea offers it, and invariably takes refuge in the depths. It requires water having a depth of at least 1,600 feet. Is this a matter of taste merely, or is it because the eggs develop properly only under great pressures? This point is not yet elucidated. Among the localities where the conditions are found favorable in proximity to the coast may be mentioned the strait of Messina. Eels evidently visit this locality in large numbers, since the strong currents here often bring eggs and Leptocephala to the surface. In 1895, Prof. Grassi found the latter here by thousands; and when the currents are gentle, an almost certain method of procuring them consists in opening the easily captured Orthagori-cus mola. This fish, which inhabits the deep sea, always contains a few larvæ of Murenidæ in its digestive tube. These larvæ are met with from February to September and have long been known. They have been called by the name of Leptocephalus brevirostris, and it is they that are the young—the larval form—of the common eel, Anguilla vulgaris.

The accompanying figures, which we owe to the kindness of Prof. Grassi, represent the leptocephalus under consideration. It is from 2¼ to 2¾ inches in length; and the extreme height of its body, which is very thin, forms a striking contrast with the somewhat cylindrical shape of the young eel. There is no doubt, however, of the connection between the leptocephalus and the eel. Prof. Grassi has directly observed the transformation of the leptocephalus in an aquarium, and, although the young eel is always shorter than the leptocephalus whence it proceeds, that is due to the fact that the latter, during its transformation, does not take any food and necessarily diminishes. While from the view point of external form the leptocephalus differs very greatly from the eel, there is, on the contrary, a complete concordance in the internal anatomy. The myomeras, the vertebral arches and the spinal ganglions are of the same number in each, and the rays of the pectoral fin of the leptocephalus are of the same number as those

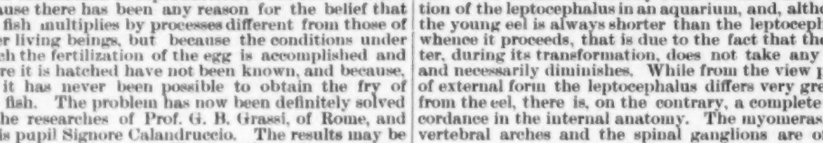


Fig. 1.—YOUNG EELS.

of the corresponding fin of the eel. We cannot enter here into the technical details given by Prof. Grassi, notwithstanding their interest; but it is well to remark that such interest is rather of a general order. While it is well to know what modifications occur or do not occur in the leptocephalus, it is not necessary to be acquainted with them in order to ascertain whether such transformation really takes place, since, through Prof. Grassi's direct observation, we know that the change occurs, and that the leptocephalus becomes a young eel.

In order briefly to recapitulate the history of the reproduction of the eel, we shall say, then, that the latter descends the rivers from October to January (in Italy at least) and that it reaches the deep sea, where (according to specimens occasionally thrown up by the currents) it undergoes evident modifications. Its eyes acquire dimensions that they never possess in fresh water, and it reaches sexual maturity, a thing that never occurs in rivers, nor in captivity, where we nevertheless find eels of 8 to 12 inches in which the sexual products do not succeed in developing. Reproduction takes place in deep water after the eel has lived therein for some time (a few months), and the pressure and chemical constitution of the medium (and perhaps also other factors that escape us) evidently play a great part in the development of the sexual aptitudes. Eggs are found from the month of August to January, and the Leptocephali show themselves from February to September.

The duration of leptocephalic life is unknown. It is known, however, that a month is sufficient for the transformation into a young eel. It is Prof. Grassi's opinion that the young eel, that which ascends the rivers in spring, is already a year old; but of this year how many months belong to the larval state? This is a point to be cleared up.

And what becomes of the eel that has reproduced its kind? The general opinion is that it dies; that it does not return to fresh water, but ends its existence in the sea shortly after spawning. Such is the opinion given by Cunningham in his excellent "Natural History of the Marketable Marine Fishes of the British Islands."

This is very likely, moreover, since in fresh water we never find eels having the appearance of those that have lived in the sea, and most certainly if the latter returned to the rivers they would, for a time at least, preserve the peculiar character of the eyes that they had acquired in salt water.

Prof. Grassi has therefore very completely solved the problem of the eel; but we must say that he has not stopped here, for he has also studied the problem of other Murenidæ (Congromuraena mystax and C. Balearica, Ophichthys, Nettastoma, Saurenchelys, etc.), and, through a comparison of the larvæ and adults, has been able to show that all of the Murenidæ studied (save two, Chlopsis bicolor and Myrus vulgaris) first pass through a leptocephalic larval stage.

The details of these researches will be found in a memoir that he is publishing, but it has appeared to us useless to await this publication in order to make known the valuable work done by the Roman zoologist and his magistral elucidation of a problem that has defied so many naturalists.

In connection with the subject of the reproduction of eels, it may be of interest to note that the belief once universally entertained that eels present no distinction of sex seems to have been shared by the Massachusetts and Narragansett Indians, who, respectively, called the common fresh and salt water eels (Anguilla Bostoniensis) Nequttikaog and N'quitteconnauog, dialectic variations of the same word, meaning "they go singly," or "one by one."

The Narragansetts, however, observed that there was at least one kind of an eel that apparently mated, and named the fishes of this species Neeshauog, meaning "they go in pairs." This name has been perpetuated, locally, in Massachusetts, in the form Neshaw, as the popular appellation for an eel that is sometimes taken in the salt ponds of Martha's Vineyard, and that Dr. Storer (Report on the Fishes of Massachusetts) supposes to be the silver eel (Muræna argentea).

The fishes so designated by the Indians may have been sea lampreys (Petromyzon Americanus), the sexes of which usually ascend rivers in pairs, aid each other in piling up heaps of stones among which to spawn, and frequently exhibit evidences of mutual attachment.

UTAH UINTAITE DEPOSITS.

There has been published in the New York Tribune part of the seventeenth annual report of the United States Geological Survey, giving an account of "The Uintaite (Gilsonite) Deposits of Utah," and prepared by George Homans Eldridge. The name uintaite was given by Prof. W. P. Blake in 1885 to a variety of asphalt found in the vicinity of the Uinta Mountains in Utah. The name gilsonite, of a later derivation, was adopted because the substance was brought into prominence as an article of utility through the efforts of S. H. Gilson, of Salt Lake City. The trade knows it better by the latter name.

According to Mr. Eldridge, uintaite is employed chiefly in the manufacture of black, low grade brush and dipping varnishes, such as are used on the various kinds of iron work and as baking japans. It is employed by one company for mixing with an asphaltic limestone in the manufacture of paving material. Other uses, according to E. W. Parker, in "Mineral Resources of the United States" for 1893, are: preventing electrolytic action on iron plates of ships' bottoms, for coating barbed wire fencing, etc., for coating sea walls of brick or masonry, for covering paving brick, for acid proof lining for chemical tanks, for roofing pitch, for insulating electric wires, for smokestack paint, for lubricants for heavy machinery, for preserving iron pipes from corrosion and acids, for coating poles, posts and ties; for torpedo proof pile coating, for covering wood block paving, as a substitute for rubber in the manufacture of cotton garden hose, and as a binder pitch for culm in making brickette and eggette coal. Mr. Eldridge is inclined to believe,

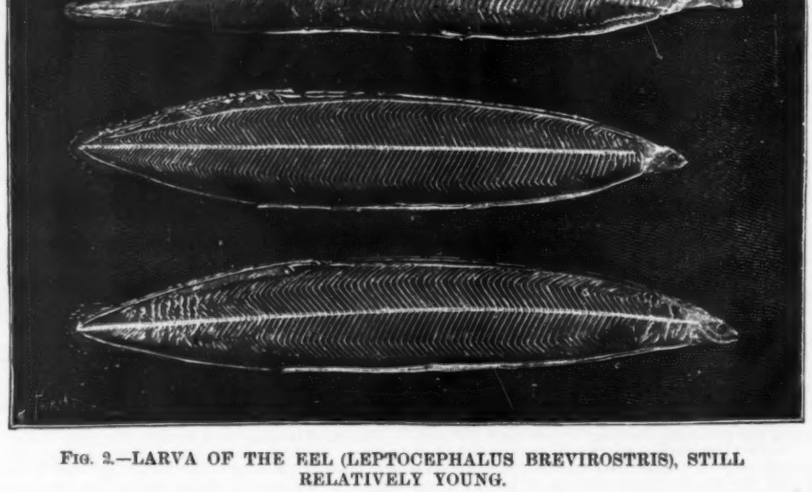


Fig. 2.—LARVA OF THE EEL (LEPTOCEPHALUS BREVIROSTRIS), STILL RELATIVELY YOUNG.

however, that the uses of gilsonite as thus enumerated by Mr. Parker are in most instances still in the experimental stage.

In his paper, Mr. Eldridge treats of the classification of hydrocarbons and allied substances, chemical relations between hydrocarbons, resemblances and differences between the asphaltites, analysis of uintaite, geology of the Uinta Basin, and its topographical features, distribution of uintaite and allied hydrocarbons in the Utah fields, of the various uintaite veins, estimated tonnage of the uintaite fields of Utah, the exploitation of the veins, and commercial considerations.

The veins are known as the Duchesne, Culmer, Seabolt, Bonanza, Cowboy and Black Dragon. The most important locality of uintaite or gilsonite is the region immediately north and south of the White River, near the eastern edge of the Uncompahgre Reservation. The veins are here known as the Little Bonanza, Big Bonanza and Cowboy; they have not yet been exploited. The Duchesne vein, which lies near to and is named after Fort Duchesne, has been worked for several years, and is opened to a depth of 105 feet. The St. Louis Gilson Asphaltum Company controls the greater part of this vein, and has shipped a comparatively large amount of gilsonite in the five or six years it has been operating.

The Culmer and Seabolt veins cross the western edge of the Uncompahgre Reservation in the vicinity of the fortieth parallel. Only the Culmer is workable of these two, and this at a great disadvantage. The Black Dragon vein is situated in the region of Upper Evacuation Creek, and is one of great promise. The total tonnage contents of all these uintaite veins is estimated at 23,744,582. Mr. Eldridge says: "Mining for uintaite will be conducted after the ordinary methods, by means of shafts and tunnels. With the establishment of hoists and conveying machinery, of especial necessity will be the installation of a ventilating plant, for the dust derived from the gilsonite in mining is exceedingly annoying, penetrating both skin and lungs, and there remaining, except under the action of a solvent, impossible, of course, in the latter case. This peculiarity of the mineral is due to its insolubility in water, and to its softening under the temperature of the body. From the skin of the miner gilsonite dust is commonly removed by the application of kerosene oil. Besides the harmful results in breathing it, the dust has proved a dangerous element in mining, being highly explosive when its mixture with atmospheric air acquires a certain ratio, and it is then disturbed by the accidental fall of a lighted candle through it. Safety lamps can be used only with difficulty, on account of the heat melting the substance and forming a film over glass or gauze. Thus far ventilation has not been attempted, the men using aspirators, sponges, or other methods, the dust of the mine being laid once a week by spraying the walls with water, which finds its way to a sump and is raised in buckets."

COMMERCIAL CONSIDERATIONS.

The region within which the uintaite (gilsonite) veins occur is deficient in transportation routes. From the north it is inaccessible except by very indirect roads. To the south it is separated from the valley of the Grand and Price Rivers by the rugged Roan or Book Plateau and its canyons, though the travel of to-day is in this direction, the product of the Culmer and Duchesne Mines being taken by wagon to Price, on the Rio Grande Western Railway. Up Strawberry Valley and across the Wasatch Range the route is somewhat more difficult than the last, and the distance to railroad is considerably greater. The mines in the edge of Colorado now ship their product by wagon over a circuitous and hilly road, via Meeker, to Rifle, on the Denver and Rio Grande Railroad, 125 miles. It is thought possible, however, by those familiar with the country, to find a feasible route 50 to 70 miles shorter than this directly southward along the State line. The Bonanza and Cowboy group of veins is a little more remote from Rifle than are the Colorado openings, though, perhaps, attended with no greater difficulties of transportation. By the way of Fort Duchesne to Price the route from these veins is about 180 miles. The vein of uintaite (gilsonite) on Upper Evacuation Creek is, perhaps, a little more inaccessible than any of the others, unless it should be proved possible to establish a route directly south across the Roan or Book Plateau, when it would become the nearest of all the deposits to railroad communication.

The cost of freighting the product of the Duchesne and Culmer mines to rail is now $12 to $15 per ton. Railway freight to Chicago is said to be about $9 per ton. The total cost of mining and placing the material in Chicago or St. Louis is therefore not far from $25 per ton. Office and management expenses may increase this to $30. The present price per ton in Chicago and St. Louis for the best grade is $40 to $50, leaving a net profit of $10 to $20. The factors in a reduction of the price to the trade will be railroad transportation direct from the Uinta Basin, which seems probable at a future day, and competition, which will arise should any equable distribution of mining claims be made among the numerous companies that will doubtless be inclined to work these great deposits.

SOME ADVANTAGES OF GILSONITE.

By some manufacturers the use of gilsonite in preference to other asphalts is considered advantageous from the standpoint of economy, as it is said to require less linseed oil to obtain equally satisfactory results, to have a greater capacity for the thinning medium with correspondingly less deterioration from its use, and to maintain an equal bulk of product with employment of a smaller percentage than of other asphalts.

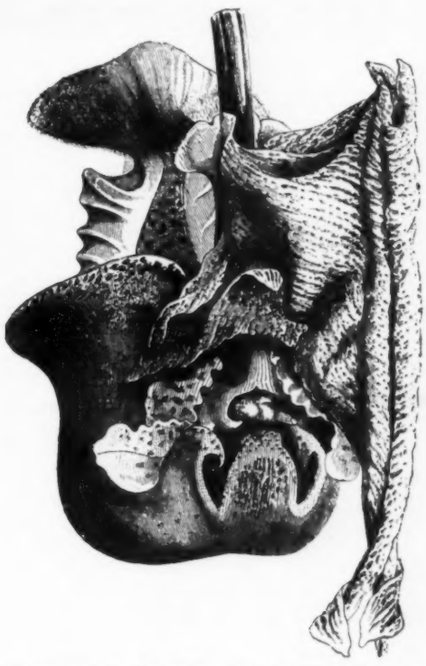
The present cost of varnishes of the first quality made from gilsonite is about $1.25 per gallon, and somewhat lower for lower grades. From the evidence gathered by Mr. Eldridge, the opening of the gilsonite veins and competition among mining companies would tend to lower the price of the raw material to manufacturers, but many of the latter do not believe an increased supply of this would materially lower the price of the varnish, as competition has already brought this to a limit. There would result, however, an improvement in quality among those who are now inclined to adulterate with resin, and the foreign asphalts used for the same purpose would be driven almost entirely from the markets of the United States. The quantity of gilsonite used by varnish manufacturers would also doubtless be considerably increased, but the total consumption for this purpose would always be comparatively small, for among even the larger concerns a carload often lasts six months.

In the manufacture of paving cement, gilsonite of the second grade is melted with petroleum residue in a tank similar to that used for its liquefaction with linseed oil for use in varnish making. To the heated mixture is added ground asphaltic limestone carrying, perhaps, an average of 18 to 20 per cent. asphalt. After thorough mixing and heating, the material is drawn from the tank into barrels and stored ready for shipment. For paving it is remelted, the requisite amount of sand is added, and the mixture is then spread like the ordinary asphaltic paving material in such wide use in the larger cities.

THE CORYANTHES.

THE members of this extraordinary section of the Stanhopea tribe, which are found rather widely distributed in tropical America, have been known to science for upward of three-quarters of a century. Although the plants have remained uncommon, the limited number of them which have flowered in gardens have caused more wonder and admiration by reason of the extraordinary structure and general dissimilarity to other flowers than have any of the showier and more popular species and genera. Every portion of the floral structure in Coryanthes affords proof of the correctness of the theory that orchid fertilization is brought about by insect agency, and what was conjectured from a study of the plants under cultivation has been fully substantiated by such careful observers as Dr. Crüger, formerly director of the botanic gardens, Trinidad; Mr. J. Rodway, F.L.S., and others, whose investigations were published in former issues of this journal.

CORYANTHES FIELDINGI—FRONT VIEW OF FLOWER.



CORYANTHES FIELDINGI—BACK VIEW OF FLOWER.

The Coryanthes are strictly epiphytal, and it was noted by importers that the specimens obtained by collectors were mere tufts of pseudo-bulbs proceeding from long oval masses of roots, and with scarcely a particle of moss or other substance or growth about them. These suspended masses were, according to the collectors, the homes of innumerable ants, and it was even asserted that the presence of the ants was essential to the well-being of the Coryanthes. This, however, as Mr. Rodway explained, is only another of Nature's wise provisions—the massed root growth of the plant supplies a congenial home for the ants, who in return attack the numerous other insects which would injure the plants, and thus in exchange for lodgings give protection.

Our illustrations of Coryanthes Fieldingi (Figs. 1 and 2), one of the oldest but still one of the most rare species, will indicate the size that the flowers of most of the Coryanthes attain. The structure of the flower is exceedingly strange, and not the least remarkable feature about it is the contrast between the membranous sepals and petals and the thick fleshy labellum, the former soon curling back into comparative insignificance, leaving the large and complicated lip as the chief attraction. As soon as the flower expands a strong and penetrating odor is emitted, and, to quote Dr. Crüger's words, "large humble bees, noisy and quarrelsome, are attracted at first by the odor; but this probably only gives notice to the insects. The substance they really come for is the interior lining of the labellum, which they gnaw off with great industry. They may be seen in large numbers fighting with each other for a place on the hypochile. Partly by these contests, partly perhaps intoxicated by the substance they are consuming, they tumble down into the bucket (epichile), which is half filled with the fluid secreted by the horn-like organs at the base of the column. They then crawl along the anterior inner side of the bucket, where there is a passage for them. If one is early on the lookout—for these Hymenoptera are early risers—one can see on every flower how fecundation is performed. The humble bee, in forcing its way out of its involuntary bath, has to exert itself considerably, as the mouth of the epichile and the face of the column fit together exactly, and are very stiff and elastic. The first bee that is immersed will have the gland of the pollen masses glued to its back. The insect then generally gets through the passage, and comes out with this peculiar appendage, to return nearly immediately to its feast, when it is generally precipitated a second time into the bucket, passing out through the aperture, and so inserting the pollen into the stigma while it forces its way out, and thereby impregnating either the same or another flower. I have often seen this, and sometimes there are so many of these humble bees assembled that there is a continual procession of them through the passage specified."

The above remarks related to Coryanthes macrantha, but they apply equally to other species. The congregating of the insects takes place on the cap above the ribbed mesochile, and the fall of the insect into the bucket, and its passage out, during which the act of fertilization takes place, is shown by the position of arrows.

The genus was founded by Sir W. J. Hooker in 1831 on C. maculata, joining with it C. speciosa and C. macrantha, which had previously been known as Gongora, and at different periods some ten or a dozen other species have been added. The prevailing colors of most of them is yellowish, with crimson and purple markings; though, as in the case of the C. maculata vitrina, imported by Messrs. F. Sander & Company, which is wholly greenish-yellow, varieties have appeared in which the colored marking is suppressed.

A plant of C. macrantha flowered recently with J. H. Kitson, Esq., Elmet Hall, Leeds (gr., Mr. T. Bonsall). A flowering plant of C. elegantium was figured under the name of C. macrantha in Gardeners' Chronicle, May 6, 1882, pp. 593 and 597.

Of comparatively recent introductions, five remarkably beautiful species may be specified, viz., C. macrocorys, distinguished by its slender, ungrooved mesochile and narrow and long hood; C. leucocorys, with rich purplish-crimson bucket and pure white hood; C. Bungerothii, a rich yellow lipped species, spotted inside the lip with bright crimson, and in which the hood is prolonged over the neck-like mesochile, like a cape; C. Wolfii and C. Mastersiana, both of which are described by Consul F. C. Lehmann as of a new section of Coryanthes, with stout, ascending inflorescence, in the Gardeners' Chronicle, October 24, 1891, p. 483. The former has flowered in the Royal Botanic Gardens, Glasnevin, Dublin, and proved a very fine species.

Coryanthes, being epiphytal plants, require to be grown under cultivation in baskets, and with no great bulk of material, such as peat or sphagnum moss, around them. During growth an unlimited supply of rain water should be afforded, and the plants should be placed in a warm, moist, but airy house. After flowering is past, the condition of the Mexican house is best suited to their needs, but at no period should they be exposed to cool treatment. At the same time there is every reason to believe that the scarcity of the plants in gardens is mainly due to their being kept continually in the same excessively warm and too often ill ventilated house. It should be borne in mind that, whether growing in hot or cool houses, all orchids require ventilation.—J. O'Brien.

CORYANTHES LEUCOCORYS.

This species well shows the peculiar structure of the genus. A plant is now in flower in the botanic garden, Edinburgh, carrying one flower upon the pendulous

scape, which springs from the base of the furrowed pseudo bulbs. They are short lived; the sepals soon collapse, and, indeed, the whole flower lasts but three or four days. The principal attraction in the flower is, perhaps, the immense helmet-like structure into which the secretion drops—this being of a pale coral pink, and the ivory hood white. The plant has been grown in an unshaded part of a pit devoted to Nepenthes, and in this position it is well suited. A figure of this species is to be seen in Lindenia, t. 293; its habitat is Peru.—R. L. H., The Gardeners' Chronicle.

ARE MEN OF GENIUS DEGENERATES?

THE theory of Lombroso, that genius is a form of degeneration, is opposed in the Revue des Deux Mondes (Paris, June) by M. G. Valbert. The Literary Digest translates as follows: After telling us that the Italian scientist has "passed his life in searching for and discovering cruel truths," the critic goes on as follows:

"The last of his [Lombroso's] discoveries is perhaps the most alarming, and he speaks of it with relish. It is with true enjoyment that he endeavors to persuade us that if alcoholics, criminals, cretins, and deaf mutes are degenerates, the great men are their cousins german, that genius is a sort of degenerative psychosis, belonging to the family of the epilepsies. . . .

"Lombroso believes that, after all, his theory has its consoling side; there comes to its aid the system of compensations, which has decreed that every advantage that is acquired shall have its drawback and that every gain shall be accompanied by a loss. 'The reptiles,' says Lombroso, 'have more functions than we, the monkeys have a greater number of muscles and an entire organ—the tail—that we lack. Only by losing these advantages have we gained our intellectual superiority.' The man who succeeds in convincing himself that his mind would fall suddenly to a lower scale if he had a tail, quickly consoles himself for not having one, and when we show that genius is a psychosis, we reconcile to their lot all minds that are mediocre or less than mediocre. They will even congratulate themselves that they have no kind of talent, for, according to Lombroso, 'the man of talent, even of genius, presents slight but real anomalies, which give occasion for injurious pathologic reactions whose traces are found in the tendency of his children to degenerate.' . . .

"But it is not sufficient to affirm that the theory of the psychosis of genius is a consoling truth; it is necessary to demonstrate that it is true, and people who are difficult to please will think perhaps that, when it comes to proof, Lombroso is satisfied with very little. This medical alienist, with his experiments and his skill, is a laborious compiler of anecdotes, which furnish him his strongest arguments. Some are curious, others are suspicious; most are less conclusive than he thinks."

After quoting a number of typical anecdotes and giving a brief sketch of Lombroso's ideas, most of which are already familiar to our readers, M. Valbert resumes his criticism as follows:

"The morose critics of whom I have spoken will perhaps complain that there is a good deal too much that is arbitrary in Lombroso's reasoning. He begins by asserting that the normal man is he who uses his mind only to gain his daily bread; it follows that men of superior intelligence are encroaching in some degree on common rights, that genius is a perversion and anomaly, and every anomaly is a case of disease. It is certain that men of genius do not abound, and if we are speaking only of great statesmen, Nature thinks she has done well if she produces three or four in a century. But M. Lombroso has a short memory; he forgets his first principles till they turn against him and confute his paradoxes. He declares that there are no exceptions in the world, that by virtue of what he calls the 'serial law' of his beloved statistics no phenomenon is produced that is not the expression of a numerous series of analogous facts, less distinct and less apparent. We may conclude from this that genius also is but the last term of a series. Numbers of men who have it not yet possess in a rudimentary state some of the qualities that it unites in all their glory—we may call these 'genial' men, and they have this advantage, they are very easily studied; they are petty suns that we may look at directly, without being dazzled; they do not oblige us to shade our eyes.

"There are 'genial' men in all ranks of society, in all classes, in all professions, in the country as in the city, and often amid the poor and humble. . . .

"But let us talk now only of the real genius. . . whether he paints or builds, whether he is sculptor or poet, whether he composes symphonies, epics, or dramas, whether he guides the destinies of a great people or leads armies in the field; we admire, equally with the extent of his thought and the grandeur of his conceptions, the justice of his view, the close connection of all parts of his work, the harmonious complexity of his designs and the simplicity and wisdom of his processes, the deep sagacity which, loving the real and the possible, sacrifices to them all chimeras, the rhythm of a will always regulated and always even, the obedience of a powerful imagination that consents to let itself be ruled by a sovereign and impassible reason.

"'These are degenerates, I tell you!' cries M. Lombroso from Turin, 'and you may be certain that many of them have protruding ears, an asymmetric visual field, and the handwriting of an epileptic or a lunatic!' We must not suppose that he is making fun and that he is putting our credulity to the test. This would be unfair to him. I believe in his seriousness as much as I doubt the infallibility of his methods. Has he his hours of doubt? Do disquiet, remorse, ever attack him? . . . Who knows? In his chapter on 'mattoids' he tells of a learned professor whose taste ran to enormities and who maintained that sea water owed its medicinal virtues to the expiration of fishes. 'And nevertheless his works,' he adds, 'contain very fine things and have reached a second edition; none of his colleagues ever suspected him of insanity. In what class shall we place him? Certainly in a rank midway between the insane person, the man of genius and the graphomaniac; with this last he has in common sterility of object, and the calm and steadfast investigation of paradoxes.' M. Lombroso is imprudent; does he not fear that some of his readers will suspect him of having doubled on himself and of applying the rod to his own back?"—Translated for the Literary Digest.

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